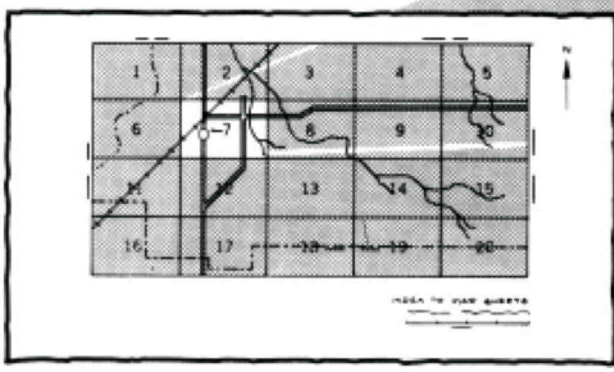
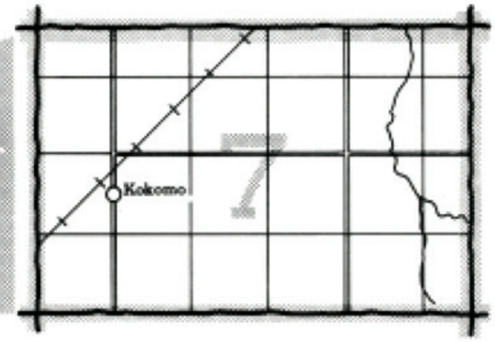
SOIL SURVEY OF
WINNEBAGO COUNTY, WISCONSIN

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
in cooperation with the
RESEARCH DIVISION OF THE
COLLEGE OF AGRICULTURAL AND LIFE SCIENCES
UNIVERSITY OF WISCONSIN

HOW TO USE

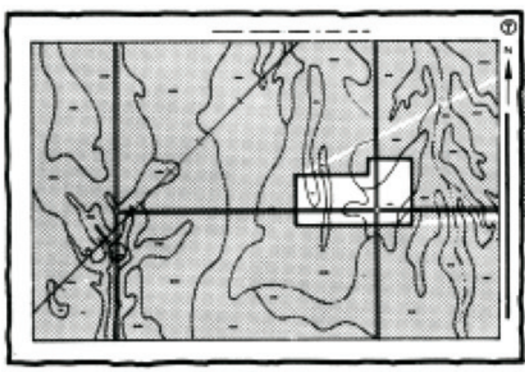
1. Locate your area of interest on the "Index to Map Sheets"

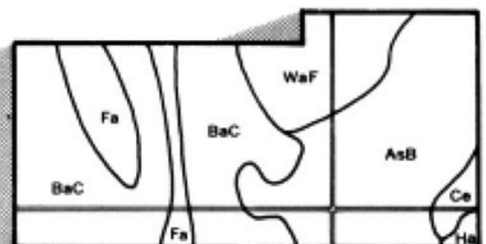




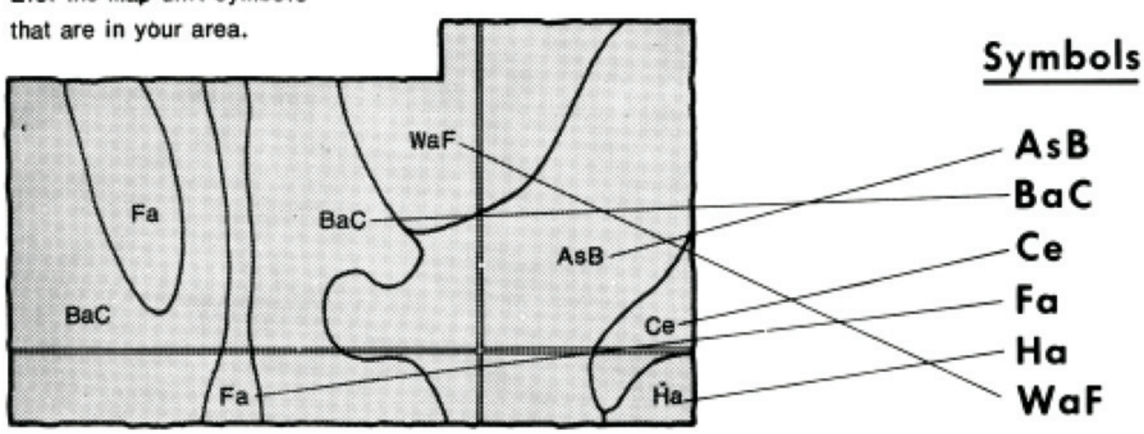
2. Note the number of the map sheet and turn to that sheet.

3. Locate your area of interest on the map sheet.



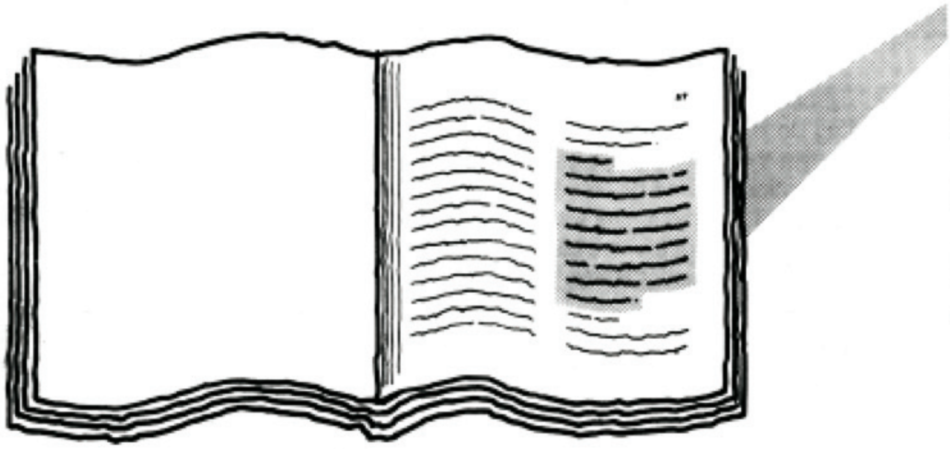
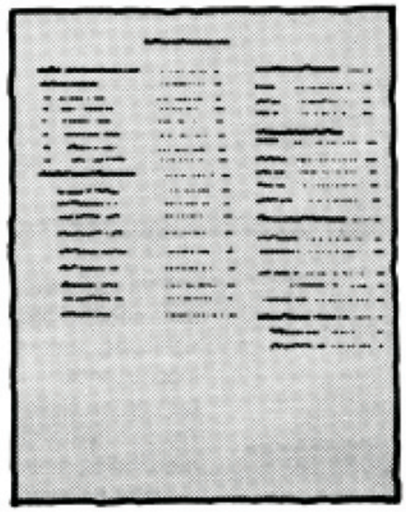


4. List the map unit symbols that are in your area.

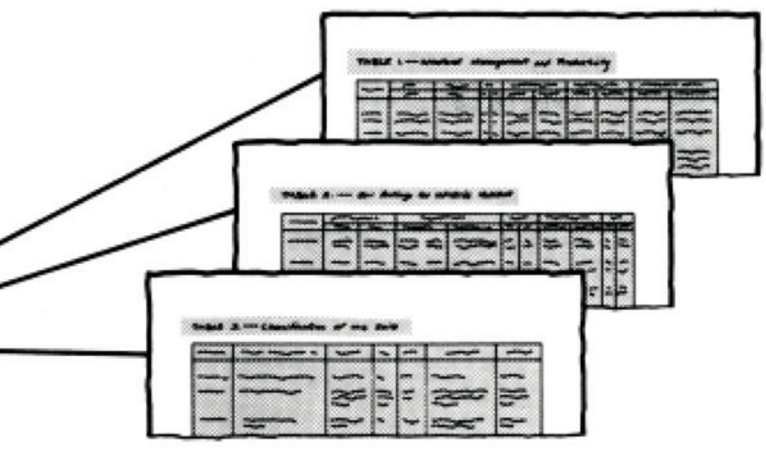
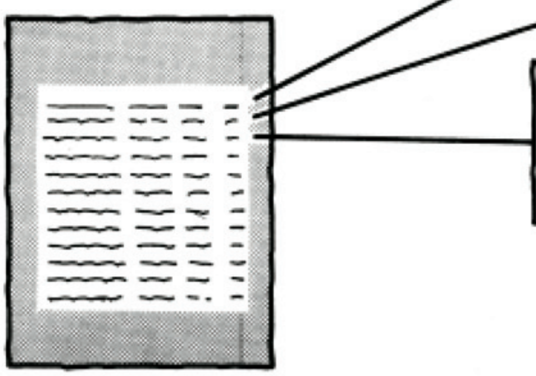


THIS SOIL SURVEY

5. Turn to "Index to Soil Map Units" which lists the name of each map unit and the page where that map unit is described.

6. See "Summary of Tables" (following the Contents) for location of additional data on a specific soil use.

7. Consult "Contents" for parts of the publication that will meet your specific needs. This survey contains useful information for farmers or ranchers, foresters or agronomists; for planners, community decision makers, engineers, developers, builders, or homebuyers; for conservationists, recreationists, teachers, or students; to specialists in wildlife management, waste disposal, or pollution control.

This soil survey is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other federal agencies, state agencies including the Agricultural Experiment Stations, and local agencies. The Soil Conservation Service has leadership for the federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was performed in the period 1973-1976. Soil names and descriptions were approved in 1977. Unless otherwise indicated, statements in this publication refer to conditions in the survey area in 1976. This survey was made cooperatively by the Soil Conservation Service and the Research Division of the College of Agricultural and Life Sciences, University of Wisconsin. It is part of the technical assistance furnished to the Winnebago County Soil and Water Conservation District. The fieldwork was partly financed by the Winnebago County Soil and Water Conservation District.

Soil maps in this survey may be copied without permission. Enlargement of these maps, however, could cause misunderstanding of the detail of mapping. If enlarged, maps do not show the small areas of contrasting soils that could have been shown at a larger scale.

Cover: Cattails on Houghton muck, ponded. This soil provides excellent wildlife habitat.

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Issued May 1980

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Foreword

This soil survey contains information that can be used in land-planning programs in Winnebago County. It contains predictions of soil behavior for selected land uses. The survey also highlights limitations and hazards inherent in the soil, improvements needed to overcome the limitations, and the impact of selected land uses on the environment.

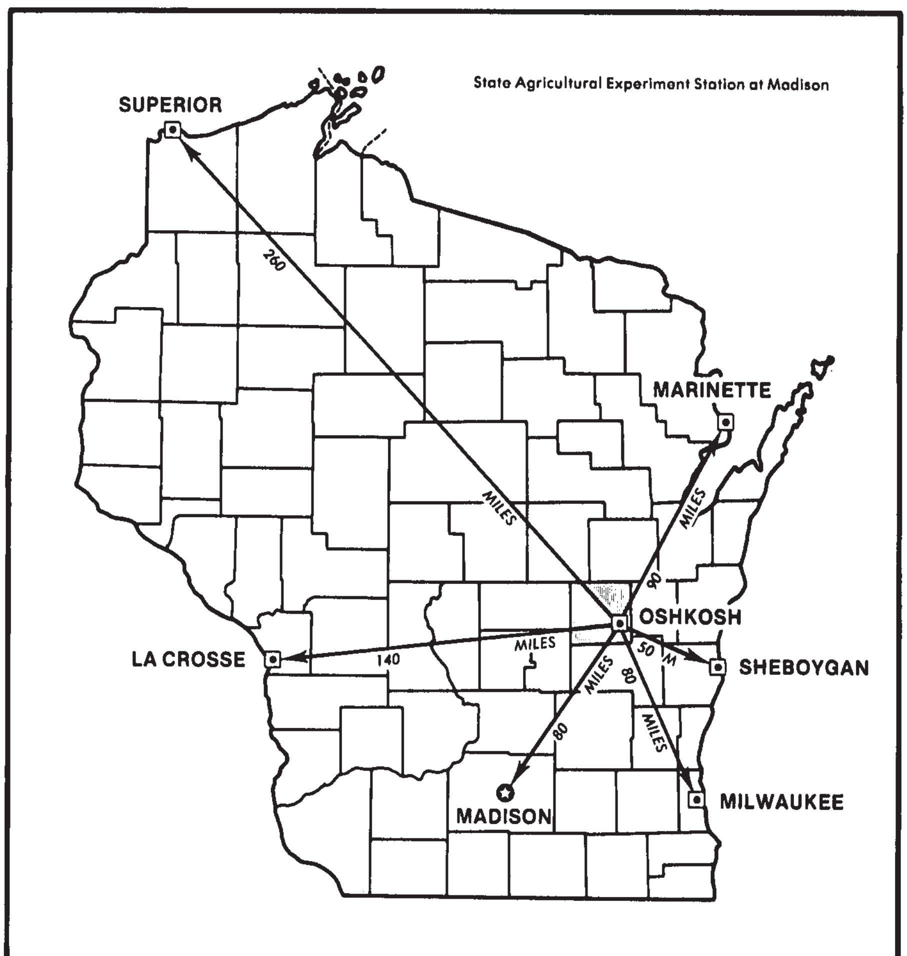
This soil survey is designed for many different users. Farmers, foresters, and agronomists can use it to evaluate the potential of the soil and the management needed for maximum food and fiber production. Planners, community officials, engineers, developers, builders, and home buyers can use the survey to plan land use, select sites for construction, and identify special practices needed to insure proper performance. Conservationists, teachers, students, and specialists in recreation, wildlife management, waste disposal, and pollution control can use the survey to help them understand, protect, and enhance the environment.

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are shallow to bedrock. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

These and many other soil properties that affect land use are described in this soil survey. Broad areas of soils are shown on the general soil map. The location of each soil is shown on the detailed soil maps. Each soil in the survey area is described. Information on specific uses is given for each soil. Help in using this publication and additional information are available at the local office of the Soil Conservation Service or the Cooperative Extension Service.

J. C. Hytry

Jerome C. Hytry
State Conservationist
Soil Conservation Service



Location of Winnebago County in Wisconsin.

SOIL SURVEY OF WINNEBAGO COUNTY, WISCONSIN

By Michael J. Mitchell, Soil Conservation Service

Fieldwork by Neil R. Babik, Kenneth A. Denow, Michael J. Mitchell, Larry L. Nazke, and Bruce A. Roberts

United States Department of Agriculture, Soil Conservation Service, in cooperation with the Research Division of the College of Agricultural and Life Sciences, University of Wisconsin

WINNEBAGO COUNTY, created in 1840, is in the east-central part of Wisconsin (see map on facing page), in the Fox River Valley industrial district. Lake Winnebago, the largest lake within the State, forms most of the eastern border. The county has a total area of 369,920 acres, of which 84,000 acres is water, the largest area of water in any county in the State. The county is mostly nearly level or gently sloping. It has no significant areas of rough land, but it does have large expanses of shallow lakes and adjacent marshes. The county is more highly industrialized and more densely populated than is typical in Wisconsin. Manufacturing paper products is the main industry. Dairying is the principal farm enterprise.

The major cities and villages are Menasha, Neenah, Omro, Oshkosh, and Winneconne. Oshkosh, the county seat and largest city, has a population of about 53,000.

The population of the county was about 10,000 in 1850. It increased to about 58,000 in 1900, to 91,000 in 1950, and to 130,011 in 1970, of which 70 percent was classified as urban. The population increased by 20.5 percent between 1960 and 1970.

Winnebago County was 40 to 80 percent forested before settlement. It was chiefly hardwood forest or open, parklike oak woods intermingled with prairie vegetation. Only 7 percent of the county, some 20,700 acres, is now forested, compared with a statewide average of 43 percent. The most common trees are ash, elm, hickory, maple, and oak.

In 1976, about 961 acres of the county was sand and gravel pits and 377 acres crushed limestone pits. This acreage included only those pits larger than 3 acres.

Good management of farmland to control erosion, remove excess water, minimize pollution, and maximize economic return is needed if farming is to remain a principal enterprise. Manufacturing and the demand for services have increased the need for both town and country planning. Problems involving pollution, sewage disposal, building development, and transportation systems are increasing rapidly.

General nature of the survey area

On the pages that follow is general information on the climate of the county; the geology; the physiography, relief, and drainage; the water supply; and the history, farming, transportation, and industry.

Climate

Winnebago has a continental climate. Day-to-day changes are frequent in all seasons. Winters are long, cold, and snowy. Spring, a mixture of warm and cold periods, is sometimes short. Rainfall is heavier in spring than in other seasons but is less frequent. In many years the change from spring to summer is gradual. Summers are warm. Several periods in summer can be hot and humid, but they last only a few days. Cool periods can occur in any month in summer. The fall season begins in mid-September and often extends into November. In nearly every year after the first killing frost, some days are abnormally warm, skies are clear—sunny but hazy, and nights are cool. The change from fall to winter is often abrupt.

In all seasons, storms accompany changes from one air mass to another, particularly from late in fall well into spring, when changes occur every 2 or 3 days. Temperatures in the immediate vicinity are tempered by Lake Winnebago. The lake usually freezes after mid-November. The ice, which is often 2 or 3 feet thick, breaks up early in April and is usually gone by mid-April.

The average date of the last 32-degree temperature in spring is May 9. The first in fall is October 4. The growing season, defined as the number of days between the last 32-degree temperature in spring and the first in fall, averages 148 days. It varies slightly within the county, depending on the nearness to water and the location—a valley or a hilltop.

Precipitation is usually adequate for crops. Moisture is usually deficient in July and August, but severe drought affecting all crops is rare. Precipitation in summer falls in

showers and tends to be erratic and variable. Hail falls on an average of 2 days a year, usually in May.

Table 1 gives data on temperature and precipitation for the survey area as recorded at Oshkosh in the period 1930 to 1959. Table 2 shows probable dates of the first freeze in fall and the last freeze in spring.

In winter the average temperature is 20.5 degrees F, and the average daily minimum temperature is 12.1 degrees. The lowest temperature on record, which occurred at Oshkosh in January, 1951, is -32 degrees. In summer the average temperature is 70.1 degrees, and the average daily maximum temperature is 81.1 degrees. The highest recorded temperature, which occurred in July, 1936, is 107 degrees.

Of the total annual precipitation, 15.4 inches, or 55 percent, usually falls in May through September, which includes the growing season for most crops. In 2 years out of 10, the rainfall in May through September is less than 8.5 inches. The heaviest 1-day rainfall during the period of record was 5.4 inches at Oshkosh on August 4, 1924. Thunderstorms occur on about 30 days each year, and most occur in June and July.

Average seasonal snowfall is 43 inches. The greatest snow depth in any one winter during the period of record was 90 inches in 1959. On an average of 6 months, at least 1 inch of snow is on the ground. The amount varies from year to year.

Snowfall has varied from 20 inches in 1958 to 90 inches in 1959. The heaviest 1-day snowfall on record was 9.2 inches in February, 1959.

The sun shines 60 percent of the time possible in summer and 40 percent in winter. The prevailing wind is from the southwest in the summer and northwest in the winter. Average windspeed is highest, 13 miles per hour, in April and November.

Geology

The bedrock formations in Winnebago County are overlain by glacial drift. Rock crops out along many valley walls. Hills and ridges on the bedrock surface, covered by only a thin layer of glacial material, form similar features on the land surface. Valleys that have cut into the bedrock are filled with the glacial material. Generally they are the flat marshy areas.

Sedimentary rock formations, such as limestone and sandstone, underlie the thin veneer of glacial deposits (*4*). At their lower boundary is the crystalline rock of Precambrian age, mostly granite. The surface of the crystalline rock, about 350 feet below the surface of Lake Poygan, generally dips southeastward to where it is about 750 feet below the surface of Lake Winnebago. The surface of this granite is fairly smooth.

The sedimentary rock formations also dip southeastward at about 20 feet per mile, conforming to the slope of the underlying crystalline rock. The layer of sedimentary rock thickens toward the southeast as successively younger rocks form the bedrock surface. It ranges in thickness from 0 feet in the northwestern part of the county to about 700 feet along the margin of Lake Winnebago. The sedimentary rock just above the crystalline rock is primarily sandstone of Cambrian age. It consists of three different sandstone formations—the Dresbach, Franconia, and Trempealeau. These formations are the most productive water-yielding aquifers in the county. The Dresbach Formation is 50 to 350 feet thick. The Franconia Formation, overlying the Dresbach, is 0 to 120 feet thick. The Trempealeau Formation, overlying the Franconia, is 0 to 120 feet thick. There are no formations of the Franconia and Trempealeau in the northwestern part of the county.

Sedimentary rock of Ordovician age overlies the Cambrian Sandstone. It consists of three different formations—the Prairie du Chien, St. Peter, and Platteville-Galena. The Prairie du Chien Limestone overlies the Trempealeau Sandstone. The St. Peter Sandstone, which overlies the Prairie du Chien Limestone, is a productive water-yielding unit. The combined thickness of the Prairie du Chien and St. Peter Formations is 0 to 200 feet. The Platteville-Galena Limestone overlies the St. Peter Sandstone. It is 0 to 170 feet thick.

The bedrock surface in Winnebago County has been dissected by preglacial and glacial erosion. Altitudes on this surface generally range from 450 feet above sea level in the northwestern part of the county to about 900 feet in the southwestern part. In general, the lowland areas in this bedrock surface are underlain by easily eroded sandstone. The highland areas are underlain by limestone.

The Platteville-Galena Limestone, the uppermost bedrock unit, covers most of the eastern and southern part of the county. It forms a broad, flat, southeastward sloping plain that terminates in a northwestward-facing escarpment extending from just east of Rush Lake in the southern part of the county to about 3 miles east of Medina Junction in the northern part of the county. Ritchey and Whalan soils occur in areas where it crops out at the surface.

A lowland, underlain by St. Peter Sandstone, lies parallel to and just west of this escarpment. Waukau Marsh and the Rush Lake area are in this lowland. The weakly cemented St. Peter Sandstone is exposed in small pits southeast of Eureka. It crops out southwest of the village of Rush Lake. Eleva soils occur in areas of these outcrops.

The Prairie du Chien Limestone is exposed in a broad, discontinuous belt extending diagonally from the southwest corner of the county to the north-central border. It parallels the Platteville-Galena escarpment but is separated from it by the lowland of St. Peter Sandstone. The Prairie du Chien Limestone, which has been deeply dissected, forms a series of hills and ridges. Knowles, Ritchey, and Whalan soils occur in areas where it crops out.

Generally, the sandstone of Cambrian age forms the bedrock surface in the northwestern part of the county in the Fox, Wolf, and Rat River Valleys.

A varying thickness of glacial drift covers the rock formations in Winnebago County. This drift ranges up to about 300 feet in thickness but in most places is less than 100 feet thick. The thickest deposits are in preglacial valleys under the Fox and Wolf Rivers.

The drift was deposited by the Green Bay lobe of the Wisconsin glaciation in the form of ground moraines, glaciofluvial deposits, and glaciolacustrine deposits. It is pulverized rock and other rock material transported by glacial ice and then deposited. It is also the assorted and unassorted material deposited by streams flowing from the glacier. Most of the drift is yellowish brown gravelly material deposited by the Cary ice sheet. A more recent ice sheet, the Valders, advanced over the Cary drift and deposited the reddish clayey material. This Valders drift is relatively thin compared with the thick deposits of Cary drift in preglacial valleys. In many places, the Valders drift is less than 20 feet thick.

Physiography, relief, and drainage

The physiography and relief of Winnebago County are controlled by the bedrock surface and modified by glacial erosion and deposition. Highland and lowland areas on the bedrock surface generally underlie and control the present highland and lowland areas of the land surface. Limestone underlies most of the highland areas. Sandstone underlies most of the lowland areas.

The county is mostly nearly level or gently sloping. In 96 percent of the county, slopes are less than 6 percent. Less than 1,000 acres has slopes of more than 12 percent. There are no large areas of rough land. Relief is such that farm machinery can be used in all parts of the county.

Surface features throughout the county are described in the map units under "General soil map for broad land use planning." Generally, the southwestern and south-central part of the county has the most local relief. This is the area not covered by the reddish Valders drift.

Altitudes in Winnebago County range from about 750 feet above sea level near the major lakes to about 950 feet in the southwest corner. Rush Lake is about 821 feet above sea level. The other lakes are about 747 feet.

Winnebago County, which is in the Lake Michigan drainage area, is within the drainage basin of the Fox River and its principal tributary, the Wolf River. Streams and lakes in the county either are tributaries to, or are part of, these two rivers, which flow into Lake Butte des Morts in the central part of the county.

The Fox River rises in Columbia County, enters Winnebago County near Eureka, flows northeastward through Lake Butte des Morts and Lake Winnebago, leaves the county north of Menasha, and then flows northeastward to Green Bay, where it empties into Lake Michigan. Lake Winnebago divides the river into the upper and lower Fox River. The upper Fox River flows through a fairly flat area. It drops only 35 feet in the 107 miles between Portage, in Columbia County, and Lake Winnebago (*4*). The lower Fox River drops about 167 feet in the 35 miles between Menasha and Green Bay. Its waterpower is one of the major reasons for all the industry in the lower Fox River Valley.

The Wolf River rises in Forest County, enters Winnebago County in the northwest corner, and then flows south and east through Lake Poygan and Lake Winneconne to Winneconne. It flows into Lake Butte des Morts just south of the village of Winneconne. The river drops only about 42 feet in the 80 miles between Shawano and Winneconne.

The principal source of water in the Fox-Wolf River basin is precipitation. Part of the precipitation runs off directly into streams. Part of it infiltrates the soil. Mean annual runoff is about 8 to 13 inches per year in the basin. The flow of the rivers, however, is principally from ground water 80 to 85 percent of the time.

The surface drainage pattern in Winnebago County is controlled by the bedrock. Most of the rivers and streams flow through those valleys that are underlain by the St. Peter Sandstone and the sandstone of Cambrian age.

Subsurface drainage in the glacial drift varies considerably between the area of Cary drift and the area of more recent Valders drift. The Valders drift, which covers 86 percent of the county, is the finer textured material and has the more subdued relief.

Of the 285,920 acres in the county, 31 percent of the acreage is well drained soils, 14 percent moderately well drained soils, 30 percent somewhat poorly drained soils, 15 percent poorly drained and very poorly drained soils, and 10 percent very poorly drained organic soils. Thus, about 69 percent of the acreage is soil that is saturated within a depth of 5 feet for significant periods during wet seasons. Approximately one-fourth the acreage of organic soils is flooded most of the year.

In the Valders drift area is 77 percent of the well drained soils in the county, 99 percent of the moderately well drained soils, 94 percent of the somewhat poorly drained soils, 84 percent of the poorly drained and very poorly drained soils, and 78 percent of the very poorly drained organic soils.

Of the 245,891 acres in the Valders drift area, however, only 28 percent of the acreage is well drained soils, 16 percent moderately well drained soils, 33 percent somewhat poorly drained soils, 14 percent poorly drained and very poorly drained mineral soils, and 9 percent very poorly drained organic soils.

The Cary drift area, totaling about 39,943 acres, includes the Kidder-McHenry, LeRoy-Ossian-Lomira, and Plano map units on the general soil map. About 52 percent of this acreage is well drained soils, 1 percent moderately well drained soils, 14 percent somewhat poorly drained soils, 17 percent poorly drained and very poorly drained mineral soils, and 16 percent very poorly drained organic soils.

Water supply

Winnebago County has abundant and readily available supplies of ground and surface water for nearly all anticipated uses (*4*). Sources are the surface water from the Fox and Wolf Rivers and their associated lakes and tributaries, and the ground water from sandstone, limestone, and glacial deposits. Surface water is hard and generally requires treatment. Pollution is only a local problem in the lakes and rivers, but algae are in most lakes. Ground water is hard to very hard, and dissolved iron is a problem in a large area of the county. A saline water zone borders the eastern edge of the county and underlies the areas of concentrated pumpage at Neenah, Menasha, and Oshkosh.

The sandstone aquifer underlying Winnebago County yields as much as 1,000 gallons per minute. The limestone aquifer yields as much as 50 gallons per minute to wells. The glacial drift in preglacial bedrock channels, in northwestern Winnebago County and in the upper Fox River valley, yields as much as 50 gallons per minute.

Water problems include algae and local pollution in the Lake Winnebago Pool, iron in water from the sandstone aquifer, and saline ground water in the eastern part of the county. Potential problems are the rapid decline of water levels because of interference between closely spaced wells, the migration of saline ground water toward areas of pumping, the surface water pollution from inadequate sewage and industrial-water processing plants, and the ground water pollution in limestone formations.

Winnebago County has more surface acres of water than any other county in Wisconsin. About 23 percent of the county, or 84,000 acres, is water. Most of the acreage is streams, rivers, and lakes. About 1,000 acres is small ponds.

The Lake Winnebago Pool is the slack-water area behind the Menasha and Neenah dams on the two outlets of Lake Winnebago. It has a surface area of about 265 square miles at the elevation of the crest of the dams. The spillway elevation is 747 feet above sea level. The pool includes Lakes Winnebago, Big Butte des Morts, Winneconne, and Poygan; the Fox River upstream to about Eureka in Winnebago County; and the Wolf River upstream nearly to New London in Waupaca County. Excluding Lake Winnebago, the pool covers about 7 percent of the total area of the county. Its usable capacity is about 25 billion cubic feet, or 190 billion gallons. The inflow to this pool from the major rivers is variable. The greatest inflow is from the Wolf River. Measured at New London, it is about 1,200 cubic feet per second 50 percent or more of the time. The Fox River, measured at Berlin, contributes about 840 cubic feet per second 50 percent or more of the time. The outflow is about 3,750 cubic feet per second 50 percent or more of the time.

Lake Winnebago is the largest lake within the pool and within the State. It forms most of the eastern boundary of Winnebago County. About 28 miles long and 10 1/2 miles wide, it covers 137,708 acres. Its maximum depth is 21 feet.

Big Lake Butte des Morts, maximum depth 11 feet, is about 4,505 acres. Lake Winneconne, maximum depth 10 feet, is 3,264 acres. Lake Poygan, maximum depth 11 feet, is 10,992 acres. Rush Lake, in the southwest corner of the county, is 3,070 acres. It is very shallow, averaging less than 6 feet in depth. It is at an altitude of 821 feet and empties into the Fox River through Rush Creek.

Little Lake Butte des Morts, at an altitude of 738 feet in the northeastern part of the county, is part of the lower Fox River. It has an area of 1,306 acres and a maximum depth of 12 feet.

Surface water in Winnebago County is hard, has a considerable annual range in temperature, is locally polluted, and has a serious algae problem in summer. It is hardest in winter when streamflow is principally derived from ground water. Suspended sediment in the Fox and Wolf Rivers is entrapped in the Lake Winnebago Pool. The Fox River at Omro averaged 39 parts per million of sediment from 1961 through 1963. Treated municipal sewage and industrial pollutants that enter the pool are only a minor problem because they are diluted by the large volume of water in the pool. Minor pollution problems, however, do occur locally in discharge areas for sewage and industrial wastes. Growth of algae in summer is a major treatment and esthetic problem. High water temperature, caused by the shallowness of the pool and the slow circulation of water through the pool, encourages the growth of algae. The water temperature of Lake Winnebago at Oshkosh ranges from 32 degrees F in winter to 80 degrees in summer. It averages about 35 degrees F.

Well water in Winnebago County is derived principally from the underlying sandstone aquifers. Water level fluctuations in the wells are seasonal. The water level generally rises in spring, falls in summer, rises slightly in fall, and falls in winter. Domestic wells probably have lowered the water level only slightly. Because a large percentage of the ground water is used for industrial cooling, pumping is generally greatest in summer. The water level in the Neenah, Menasha, and Oshkosh areas has been lowered by industrial pumping.

Ground water in Winnebago County is of good quality, but it is very hard and locally high in iron. In the sandstone aquifer at the eastern edge of the county, the water is saline. The hardness ranges from 600 to 2,200 parts per million in the saline water area. In the northwest corner of the county, it ranges from 64 to 110 parts per million. In the rest of the county, it ranges from 200 to 600 parts per million. The concentration of iron in the ground water ranges from 0.02 to 10 parts per million and averages 1.6 parts per million. Iron concentrations generally are highest in the highlands west of Neenah and Menasha.

The saline water area at the eastern edge of the county is part of the large saline water area that includes

parts of Brown, Outagamie, Calumet, Fond du Lac, and Dodge Counties. Saline water is more than 250 parts per million sulfate or chloride, or more than 1,000 parts per million total dissolved solids. Dissolved solids in ground water in Winnebago County are as high as 1,700 parts per million in the saline water area. The solids are largely sulfate, calcium, and magnesium.

The temperature of the ground water is nearly constant, ranging from 49 to 54 degrees. This temperature makes the ground water an excellent source for cooling water and for other purposes.

The total use of water in the county from both surface and ground water sources was estimated to be 53.6 million gallons per day in 1962. Surface water provided an estimated 77 percent of this total, and ground water 23 percent. Because of its wide availability, ground water is the principal source of water to communities other than Neenah, Menasha, and Oshkosh; to many industries; and for rural domestic and stock use. The largest user of ground water is the pulp and paper industry.

History

Jean Nicolet, a French explorer, entered the present site of Winnebago County in 1634 to negotiate a peace treaty between the Winnebago and Huron Indians and to inquire about a possible route to the Pacific. The waterways of the county were soon thereafter used by many early French explorers, missionaries, and fur traders, among whom were Marquette, Joliet, Hennepin, and Dulhut.

The first permanent settlement in the county occurred between 1729 and 1760. Settlers were mostly from New York and New England, and later, from Europe.

Winnebago County was created in 1840 from parts of Fond du Lac and Brown Counties. In 1849, the Menominee Indian lands not attached to other counties were annexed to the county. The present boundaries were defined in 1856.

Farming

Farming in Winnebago County has expanded from growing crops for home use, to wheat production, to livestock, and finally to a vast growth in dairying.

Originally, forest covered most of the county. Thus, between 1835 and 1850, the dates of extensive settlement, lumbering was the first chief industry. Farm products, such as flour, beef, pork, and potatoes, were in considerable demand in the lumber camps. The pioneer farmers obtained winter employment at the lumber camps and sawmills.

First raised in 1837, wheat became the great pioneer crop of the county. Wheat production declined rapidly, however, about 1880, as a result of chinch bug infestation, rust, and western competition. Many of the pioneer families left the county.

Raising cows, hogs, sheep, horses, and poultry was important during this period. Hay, oats, corn, barley, wheat, potatoes, and peas were the chief crops. Smaller acreages were in rye, buckwheat, flax, soybeans, sugar beets, and beans. The largest acreage was cropped to hay. In addition, wild hay was cut from the extensive marshland. Farmers found it more profitable to feed crops to the livestock and market the livestock and livestock products than to sell the crops.

By 1900, immigrants from western Europe had developed dairying as the most important type of farming in the county. Most of the dairy output was marketed as cheese and butter.

Dairying is still the main farm industry. The trend is toward fewer dairy farms but larger herds, more productive livestock, and more efficient husbandry. The number of milk cows had decreased from 32,400 in 1950 to 23,700 in 1974, but the milk produced per cow had increased (*12*). Thus, total milk production in 1974 was only slightly lower than in 1950. Milk cows along with other cattle are the chief livestock. Butter, cheese, condensed milk, powdered milk, and ice cream are the major dairy products.

The number of hogs, horses, and sheep has decreased significantly since 1900. The number of chickens decreased from 209,300 in 1950 to 155,000 in 1974, but egg production in 1974 was about the same as in 1950.

Following the trend in the State, the number of farms in the county declined from 2,357 in 1950 to 1,360 in 1975, but the farm acreage increased. The average farm in the county in 1975 was 155.2 acres, compared with 108 acres in 1950.

About 69 percent of Winnebago County was farmed in 1969. The crops grown and the cropping acreages and trends are described under "Crops and pasture."

Transportation and industry

Winnebago County has excellent highway connections. It is connected to cities north and south by U.S. Highway 41. U.S. Highways 10 and 45, the 8 State highways, and a well maintained network of paved county roads provide easy access to all parts of the county. The major highways radiate outward or pass through the major cities of Oshkosh, Neenah, and Menasha.

The numerous waterways have always played an important part in transportation in the county. Because the Green Bay-Fox River-Lake Winnebago waterway provided easy access to the interior of Wisconsin, it was used by the canoes of Indians, early explorers, missionaries, and fur traders. As early as 1844, steamboats were built and operated on Lake Winnebago and its tributary waters. During the great lumbering era, the Wolf River was used extensively to float logs down to the mill towns of Oshkosh, Fond du Lac, Neenah, and Menasha. The waterways are used extensively today for motor boating, fishing, water skiing, sailing, and canoeing.

The county is also accessible by rail, bus, and air. There are several small airports. The major airport is Wittman Field at Oshkosh.

Winnebago County was, at first, an important lumbering region. A great forest of pine stretched through the north region of the county and northward along the Wolf River. The first sawmill in the county was built at Neenah in 1835. Soon other mills were established and millions of feet of logs were cut and floated down the Wolf River to the mill towns of Oshkosh, Fond du Lac, Neenah, and Menasha. Oshkosh soon became the center of one of the richest lumbering districts in the State. Factories converted the lumber into finished products.

The rapids at the outlet of Lake Winnebago furnished the waterpower that made the county an early manufacturing center. One of the earliest manufacturing enterprises was the milling of flour. The woodworking factories and sawmills in the county were largely replaced by grist mills and flour mills. Neenah was recognized as one of the leading flour milling centers in the State. The rapid decline of wheat production in the county after 1880 resulted in a decline in the flour milling industry.

Wheat farmers were replaced by dairy farmers by 1900. Cheese factories were built, most of which are still operating. Dairying is still the main farming enterprise. Other factories market butter, condensed milk, evaporated milk, and ice cream.

Winnebago County is one of the most industrialized parts of Wisconsin. Paper is the dominant industry. The paper industry has several big mills, other smaller ones, and supporting industry. Wood products and furniture are also important. In addition, there is much activity in metal working and printing.

How this survey was made

Soil scientists made this survey to learn what soils are in the survey area, where they are, and how they can be used. They observed the steepness, length, and shape of slopes; the size of streams and the general pattern of drainage; the kinds of native plants or crops; and the kinds of rock. They dug many holes to study soil profiles. A profile is the sequence of natural layers, or horizons, in a soil. It extends from the surface down into the parent material, which has been changed very little by leaching or by plant roots.

The soil scientists recorded the characteristics of the profiles they studied and compared those profiles with others in nearby counties and in more distant places. They classified and named the soils according to nationwide uniform procedures. They drew the boundaries of the soils on aerial photographs. These photographs show trees, buildings, fields, roads, and other details that help in drawing boundaries accurately. The soil maps at the back of this publication were prepared from aerial photographs.

The areas shown on a soil map are called map units. Most map units are made up of one kind of soil. Some are made up of two or more kinds. The map units in this survey area are described under "General soil map for broad land use planning" and "Soil maps for detailed planning."

While a soil survey is in progress, samples of some soils are taken for laboratory measurements and for engineering tests. All soils are field tested to determine their characteristics. Interpretations of those characteristics may be modified during the survey. Data are assembled from other sources, such as test results, records, field experience, and state and local specialists. For example, data on crop yields under defined management are assembled from farm records and from field or plot experiments on the same kinds of soil.

But only part of a soil survey is done when the soils have been named, described, interpreted, and delineated on aerial photographs and when the laboratory data and other data have been assembled. The mass of detailed information then needs to be organized so that it can be used by farmers, woodland managers, engineers, planners, developers and builders, home buyers, and others.

General soil map for broad land use planning

The general soil map at the back of this publication shows broad areas that have a distinctive pattern of soils, relief, and drainage. Each map unit on the general soil map is a unique natural landscape. Typically, a map unit consists of one or more major soils and some minor soils. It is named for the major soils. The soils making up one unit can occur in other units but in a different pattern.

The general soil map can be used to compare the suitability of large areas for general land uses. Areas of suitable soils can be identified on the map. Likewise, areas where the soils are not suitable can be identified.

Because of its small scale, the map is not suitable for planning the management of a farm or field or for selecting a site for a road or building or other structure. The soils in any one map unit differ from place to place in slope, depth, drainage, and other characteristics that affect management.

Descriptions of map units

1. Kewaunee-Manawa-Hortonville

Well drained to somewhat poorly drained, nearly level to sloping soils that have a loamy or clayey subsoil underlain by loamy or clayey glacial till

This map unit is on glaciated uplands where the soils formed in a very thin mantle of silty or sandy windblown material over reddish glacial till. It is dominantly a broad, undulating ground moraine of little local relief and numerous swells and swales (fig. 1). Some prominent hills are much higher than the surrounding landscape.

This unit makes up about 60 percent of the land area in the county. It is about 27 percent Kewaunee soils, 17 percent Manawa soils, 16 percent Hortonville soils, and 40 percent minor soils.

Figure 1.—Broad, undulating ground moraine in Kewaunee-Manawa-Hortonville unit. The dark colored swales are Manawa soils.

Kewaunee soils, on ground, terminal, and recessional moraines, are gently sloping and sloping and are well drained or moderately well drained. Typically the surface layer is silt loam or loamy fine sand. The subsoil is mostly clay. Calcareous silty clay loam glacial till is at a depth of about 29 inches.

Manawa soils, on valley terraces and in drainageways, are nearly level and gently sloping and are somewhat poorly drained. Typically the surface layer is silty clay loam, and the subsoil is mostly silty clay. Calcareous silty clay glacial till is at a depth of about 35 inches.

Hortonville soils, on valley sides and moraines, are gently sloping and sloping and are well drained. Typically the surface layer is silt loam or loamy fine sand. The subsoil is mostly clay loam. Calcareous loam glacial till is at a depth of about 28 inches.

Minor in this unit are the Korobago, Lorenzo Variant, Menasha, Neenah, Omro, Poygan, Udorthents, Whalan, and Winneconne soils. Korobago and Poygan soils are in swales, on valley lowlands, and along upland drainageways. The Lorenzo Variant and Omro soils are on the most elevated swells of glacial till moraines. Udorthents are in urban centers and in low areas adjacent to streams and lakes. Whalan soils are on valley sides and broad till plains underlain by limestone. Winneconne, Menasha, and Neenah soils are in lake basins and on terraces.

This unit is used mainly for cultivated crops. Some tracts are pasture. Some are woodlots. Corn, alfalfa, and oats are cropped in rotation to support dairying, the main farm enterprise. Most of the urban centers in the county are on this unit.

Seasonal wetness, poor tilth, and erosion are the main concerns in farming. Ponding in swales is common in spring and after heavy rainfall. Wetness often delays tillage because the soils dry slowly in spring. Many of the soils must be tilled at the proper moisture content or the plow layer dries into hard clods.

Most of the wheat, soybeans, and fruit crops, mainly apples, are produced on this unit. The acreage in wheat and fruit crops, however, is small. A recent trend is toward larger production of soybeans. Most of the poultry and egg production in the county is also on this unit. In addition, the unit supports approximately 45 percent of the woodland in the county, mostly small woodlots.

This unit has good potential for increased production of alfalfa. The potential is only fair for production of peas and corn grown for canning. Most of the soils dry out slowly. Wetness makes harvesting difficult. The potential is good for fruit crops and woodland. The potential is good for increased production of farm crops if wetness and erosion are controlled, fertility is maintained, and tilth

is improved. The potential is poor for septic tank absorption fields because many of the soils have a seasonal high water table or restricted permeability.

Each year an increasing acreage of farmland is converted to urban use or to related uses, such as sites for country homes, lakeshore development, and recreation.

2. Zittau-Poy

Somewhat poorly drained and poorly drained, nearly level and gently sloping soils that have a clayey subsoil underlain by sandy material

This map unit is in a glacial lake basin where the soils formed in clayey water-laid sediment over sandy material. It has a broad, nearly level to gently undulating landscape of slightly elevated swells separated by nearly level swales. Many of the swells are long and narrow. Local relief commonly is less than 5 feet. This unit grades gently to adjacent lakes. It is cut by several major meandering drainageways.

This unit makes up about 18 percent of the land area in the county. It is about 26 percent Zittau soils, 17 percent Poy soils, and 57 percent minor soils.

Zittau soils, on swells and terraces, are nearly level and gently sloping and are somewhat poorly drained. Typically the surface layer is silty clay loam, and the subsoil is clay. Fine and medium sand is at a depth of 33 inches.

Poy soils, in swales, are nearly level and poorly drained. Typically the surface layer is silty clay loam, and the subsoil is clay. Fine and medium sand is at a depth of about 34 inches.

Minor in this unit are Borth, Fluvaquents, Kaukauna, Menasha, Nebago, and Neenah soils. Borth soils are on low ridges. Fluvaquents are adjacent to the major streams. Kaukauna soils are on the glacial lake basin terraces adjacent to the glaciated uplands. Menasha soils are in depressions. Nebago soils are on low, long swells and on terraces where the clayey water-laid sediment is covered with a mantle of sandy deposits. Neenah soils are on swells and terraces.

This unit is used mainly for pasture and cultivated crops. Some tracts are woodlots; about 38 percent of the woodland in the county is on this unit. Lakeshore areas are used almost exclusively for cottage sites and water-related recreational activities.

Dairying is the main farm enterprise. Corn, alfalfa, and oats are the main crops, but some acreage is cropped to wheat, soybeans, and vegetables. A recent trend is toward more soybeans and less field corn.

Wetness and poor tilth are the main management concerns in farming. In most places the seasonal high water table is within a depth of 3 feet. Ponding in swale areas is common in spring and after heavy rainfall. Wetness often delays tillage because the soils dry slowly. Drainage is needed for dependable crop production. A large acreage has been drained. On most of the acreage the soil must be tilled at the proper moisture content or the plow layer dries into hard clods. The many swampy undrained areas are used mainly as pasture or wildlife habitat.

Low sand ridges are common. These sandy areas, which are seasonally droughty, are subject to soil blowing.

If this unit is adequately drained and fertility and good tilth are maintained, the potential is good for cultivated crops. Wetness is such a severe limitation and so difficult to overcome that the potential is poor for residential and other urban uses. The potential is poor for septic tank absorption fields because of the seasonal high water table and the restricted permeability. The potential is good for development of wildlife habitat. It is also good for woodland.

3. Houghton-Willette

Very poorly drained, nearly level organic soils

This map unit is in depressional areas of glacial lake basins and in low areas adjacent to lakes and streams. The organic material is well decomposed residue from water-tolerant plants. This unit contains many marshy areas of ponded water, typically adjacent to open water areas. It is broad and nearly level and has no visible micro-relief.

This unit makes up about 7 percent of the land area in the county. It is about 60 percent Houghton soils, 30 percent Willette soils, and 10 percent minor soils.

Houghton soils, in low areas adjacent to lakes and drainageways and in the central part of basins, are nearly level and are very poorly drained. They are 51 or more inches of organic material. Approximately half the acreage is flooded with 1 to 3 feet of water most of the year. The plant cover is cattails.

Willette soils, in low areas adjacent to lakes and drainageways and near the outer rims of basins, are nearly level and are very poorly drained. They are 16 to 51 inches of organic material over clayey sediment.

Minor in this unit are Adrian, Edwards, and Palms soils. All are organic soils near the outer rims of basins and in low areas adjacent to lakes and drainageways.

Most of this unit is undrained and is used mainly for wildlife habitat and recreational activities. Some small drained tracts are used for sodfarming, field corn, or truck crops, such as carrots or lettuce. Marsh hay is harvested from some small tracts. Because a large part of this unit is adjacent to lakes and streams, it is flooded with 1 to 3 feet of water most of the year. These flooded tracts are used extensively for raising muskrats. Some undrained tracts are used periodically for pasture. Most of the county wildlife preserves and public hunting and fishing grounds are on this unit. Many parts of the unit provide storage basins for the runoff that collects during wet periods.

If adequately drained, this unit has good potential for specialty crops, such as bluegrass sod, mint, and various truck crops. It has low natural fertility, however, and is

subject not only to flooding but also to frost. Drained areas are subject to subsidence and soil blowing. If the unit is adequately drained, the potential is fair to good for some general farm crops, such as corn. The potential is good for development of wetland wildlife habitat. The many level ditches provide excellent habitat for waterfowl and muskrats. The potential is good for some recreational uses, such as sightseeing, hunting, and winter sports. It is also good for trapping fur-bearing animals. The wetness, frequent flooding, and low stability are such severe limitations that the potential is poor for residential and other urban uses. The potential is also poor for woodland.

4. LeRoy-Ossian-Lomira

Well drained and poorly drained, nearly level to sloping soils that have a silty or loamy subsoil underlain by loamy glacial till or silt loam alluvium

This map unit consists mostly of glaciated uplands interspersed with wet valleys or bottom lands. Most of the soils formed in windblown silt over glacial till. Because the silty deposits are much thicker on the bottom land, most of the bottom land soils formed entirely in the silty material. The glacial till is high in content of gravel and stones. On the uplands are prominent drumlins and recessional moraines. The drumlins, several miles long, are northeast-southwest oriented and commonly have sharp crests and short side slopes. The recessional moraines are irregularly shaped hills and knolls. The local relief in this unit commonly ranges from 10 to 30 feet.

This unit makes up about 7 percent of the land area in the county. It is about 25 percent LeRoy soils, 17 percent Ossian soils, 14 percent Lomira soils, and 44 percent minor soils.

LeRoy soils, on drumlins, knolls, and morainic ridges of till plains, are gently sloping and sloping and are well drained. Typically the surface layer is silt loam, and the subsoil is mostly silty clay loam. Highly calcareous gravelly fine sandy loam glacial till is at a depth of about 19 inches.

Ossian soils, in depressional areas and drainageways, are nearly level and poorly drained. Typically, they are silt loam to a depth of 60 inches or more.

Lomira soils, on the lower slopes of drumlins, knolls, and morainic ridges of till plains, are gently sloping and well drained. Typically the surface layer is silt loam, and the subsoil is mostly silty clay loam. Highly calcareous gravelly fine sandy loam glacial till is at a depth of about 37 inches.

Minor in this unit are Atterberry, Keowns, Lamartine, and St. Charles soils. Atterberry and Lamartine soils are on valley terraces and in drainageways. Keowns soils are in depressions and drainageways. St. Charles soils are on till plains between drumlin ridges and moraines and on high valley terraces.

This unit is used mainly for cultivated crops. The steeper and wetter acreage is in pasture and woodlots. About 5 percent of the forested acreage in the county is on this unit.

Corn, oats, and alfalfa are cropped in rotation to support dairying, the main farm enterprise. A small acreage is in barley and fruit crops, mainly apples. This unit supports a large part of the canning crops, mainly peas and sweet corn, produced in the county. The trend is toward more cash crops and less dairying. This unit supports most of the small sheep enterprise in the county. Controlling water erosion in the uplands and reducing wetness in the lowlands are the main management concerns.

The well drained soils in this unit have good potential for residential and other urban uses. The upland soils have good potential for septic tank absorption fields because they are well drained and moderately permeable. The underlying glacial till is a good source of roadfill material. The potential is good for woodland and recreational uses. If adequately drained, the lowlands have good potential for cultivated farm crops, including cash crops, such as peas and sweet corn.

5. Kidder-McHenry

Well drained, gently sloping to moderately steep soils that have a loamy subsoil underlain by loamy glacial till

This map unit is mostly on glaciated uplands where the soils formed in windblown silty deposits or sand over glacial till. It consists of ground moraines and recessional moraines separated by wet valleys that contain the thicker silty deposits. The valley sides are sloping to moderately steep. Many are glaciated limestone ridges where rock crops out. Some valley walls are loess capped outwash deposits of sand and gravel. Small areas of this outwash are in the uplands adjacent to recessional moraines. On some parts of the uplands are bedrock plateaus capped with loess and glacial till. The local relief commonly ranges from about 20 to 60 feet.

This unit makes up about 5 percent of the land area in the county. It is about 19 percent Kidder soils, 18 percent McHenry soils, and 63 percent minor soils.

Kidder soils, on valley sides, hillsides, and morainic ridges of till plains, are gently sloping to moderately steep and are well drained. The surface layer is silt loam or loamy fine sand, and the subsoil is mostly sandy clay loam. Calcareous fine sandy loam glacial till is at a depth of about 32 inches.

McHenry soils, on valley sides, low hills, and morainic ridges of till plains, are gently sloping and sloping and are well drained. Typically the surface layer is silt loam. The subsoil is silt loam in the upper part and clay loam in the lower part. Calcareous fine sandy loam glacial till is at a depth of about 32 inches.

Minor in this unit are Atterberry, Casco, Fox, Keowns, Knowles, Ossian, Ritchey, and St. Charles soils. Atterberry soils are on valley terraces. Casco and Fox soils are on valley sides, knolls, and ridges. Keowns and Ossian soils are in depressional areas. Ritchey and

Knowles soils are on valley sides and bedrock-controlled moraines. St. Charles soils are on till plains between morainic ridges and on high valley terraces.

This unit is used mainly for cultivated crops. The steeper and wetter tracts are pasture and woodland. About 5 percent of the forested acreage in the county is on this unit.

The main farm enterprise is dairying, but the trend is toward less dairying and more cash crops. Cash crops are mainly peas and sweet corn. Most of the cultivated crops are field corn, oats, and alfalfa. The main management concerns are controlling erosion in the uplands and reducing wetness in the lowlands.

This unit has good potential for residential and other urban uses. The upland soils have good potential for septic tank absorption fields because they are well drained and moderately permeable. The underlying glacial till is a good source of roadfill material. The limestone ridges are a good source of crushed limestone for roadbuilding. The potential is good for woodland and most recreational uses. The potential is also good for cultivated farm crops and cash crops.

6. Oakville-Brems-Morocco

Well drained to somewhat poorly drained, nearly level to sloping soils that have a sandy subsoil underlain by sandy material

This map unit is on glacial lake beaches and sandy outwash plains that have been reworked by wind. It has very broad, nearly level and gently sloping topography with some swales and several prominent hills. Except for the few hilly areas, local relief commonly is less than about 6 feet. The several prominent hills are very thick sandy deposits, probably stabilized sand dunes, that rise about 20 to 50 feet above the surrounding landscape.

This unit makes up about 2 percent of the land area in the county. It is about 26 percent Oakville soils, 23 percent Brems soils, 22 percent Morocco soils, and 29 percent minor soils.

Oakville soils, on the highest terraces and ridges in glacial lake basins, are gently sloping and sloping and are well drained. Typically, they are fine sand to a depth of 60 inches or more.

Brems soils, on the lowest terraces and ridges in glacial lake basins, are nearly level and gently sloping and are moderately well drained. Typically, they are fine sand to a depth of 60 inches or more.

Morocco soils, on terraces adjacent to drainageways, wet basins, and lakes, are nearly level and gently sloping and are somewhat poorly drained. Typically, the surface layer is loamy fine sand, and the subsoil and substratum are fine sand.

Minor in this unit are Fisk and Kingsville soils. Fisk soils are on glacial lake beaches between the sandy uplands and the adjacent clayey glacial lake basin. Kingsville soils are in depressional areas.

This unit is used mainly for pasture and cultivated crops. Many tracts are farm woodlots or pine tree plantations. About 7 percent of the woodland in the county is on this unit.

Corn, oats, and forage grasses and legumes are cropped in rotation to support dairying, the main farm enterprise. Low natural fertility and low available water capacity are the main management concerns in farming. Most of the soils are seasonally droughty and are subject to soil blowing.

This unit has poor potential for cultivated crops. The potential is good for growing specialty crops under irrigation. The potential is poor for dwellings with basements and for septic tank absorption fields because many of the soils have a seasonal high water table. The potential is good for pine or Christmas tree plantations.

7. Plano

Well drained, gently sloping soils that have a silty and loamy subsoil underlain by loamy glacial till

This map unit of prairie soils is on glaciated uplands where the soils formed in thick deposits of windblown silt over glacial till. It is at the highest elevations in the county. It is dominantly an undulating ground moraine with broad swells and narrow swales. The swells are long, are east-west oriented, and have long slopes.

This unit makes up about 1 percent of the land area in the county. It is about 45 percent Plano soils and 55 percent minor soils.

Plano soils, on the sides of slight rises on till plains, are gently sloping and well drained. Typically the surface layer is dark silt loam about 15 inches thick. The subsoil is mostly silty clay loam and silt loam. Calcareous sandy loam glacial till is at a depth of about 55 inches.

Minor in this unit are Grellton and McHenry soils. Grellton soils are in slightly depressed areas. McHenry soils are on the crests and upper sides of knolls and hills.

This unit is used mainly for cultivated crops. A few small tracts are pasture. The main farm enterprise is growing peas and sweet corn as cash crops. The prairie soils in this unit are some of the most productive in the county for crops. Dairying is secondary. The trend is toward more cash crops and less dairying. Some field corn, oats, and alfalfa are grown to support dairying. The main management concern is erosion.

This unit has good potential for cultivated crops and for specialty crops, such as sweet corn and peas. The potential is poor for woodland. The potential is good for residential and other urban uses. The potential is good for septic tank absorption fields because the soils are moderately permeable.

Soil maps for detailed planning

The map units on the detailed soil maps at the back of this survey represent the soils in the survey area. The map unit descriptions in this section, along with the soil

maps, can be used to determine the suitability and potential of a soil for specific uses. They also can be used to plan the management needed for those uses. More information on each map unit, or soil, is given under "Use and management of the soils."

Each map unit on the detailed soil maps represents an area on the landscape and consists of one or more soils for which the unit is named.

A symbol identifying the soil precedes the map unit name in the soil descriptions. Each description includes general facts about the soil, a brief description of the soil profile, and a listing of the principal hazards and limitations to be considered in planning management.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer or of the substratum, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer or of the substratum. They also can differ in slope, stoniness, wetness, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Kewaunee silt loam, 2 to 6 percent slopes, is one of several phases in the Kewaunee series.

Most map units include small scattered areas of soils other than those for which the map unit is named. Some of these included soils have properties that differ substantially from those of the major soil or soils. Such differences could significantly affect use and management of the soils in the map unit. The included soils are identified in each map unit description. Some small areas of strongly contrasting soils are identified by a special symbol on the soil maps.

This survey includes *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Pits, gravel, is an example. Miscellaneous areas are shown on the soil maps. Some that are too small to be shown are identified by a special symbol on the soil maps.

Table 3 gives the acreage and proportionate extent of each map unit. Other tables (see "Summary of tables") give properties of the soils and the limitations, capabilities, and potentials for many uses. The Glossary defines many of the terms used in describing the soils.

Soil descriptions

The soil descriptions on the following pages contain statements about potentials and the means of overcoming soil limitations or hazards. Some of the best methods described are controlled by local or state ordinances, which should be referred to before construction.

Ak—Adrian muck. This nearly level, very poorly drained soil is in depressional and low areas adjacent to drainageways and lakes. It is subject to frequent flooding. Areas are long and narrow or irregular in shape. They range from about 10 to 300 acres.

Typically, the upper 14 inches of this Adrian soil is black muck. The next 8 inches is dark reddish brown muck. The substratum to a depth of about 60 inches is grayish brown, loose sand. In some areas the sand substratum contains thin strata of loamy or clayey material. In places the organic material is less than 16 inches thick.

Included with this soil in mapping are small areas of Houghton, Palms, and Willette soils. Houghton soils are organic to a depth of more than 51 inches. Palms soils are underlain by loamy material. Willette soils are underlain by clay. Included areas make up 5 to 10 percent of the unit.

Permeability is moderately rapid. Surface runoff is very slow or ponded. Available water capacity is high. Reaction ranges from medium acid to mildly alkaline in the organic material.

Unless drained, this soil is saturated at or near the surface throughout most of the year. In undrained areas, root development is restricted. The response to additions of plant nutrients in undrained areas is limited by the excessive wetness. If dry, the surface layer is very friable and easily tilled.

Most of the acreage is in woodland and wetland vegetation, such as marsh grasses, sedges, reeds, redosier brush, and cattails. A few areas are drained and are used for crops and grass sod. If drained, the soil has good potential for sod and specialty crops and fair potential for cultivated crops. It has fair potential for trees. It has poor potential for recreational development and engineering uses.

This soil must be drained for dependable crop production. If drained, it is suited to corn and soybeans. It is generally unsuited to small grain and to grasses and legumes for hay. The flood hazard and a short growing season, caused by frost late in spring and early in fall, limit yields and restrict the types of crops that can be grown. Soil blowing and subsidence are hazards if the soil is drained and cultivated. Winter cover crops, controlled drainage, and restricted use when the soil is wet help to minimize these hazards. Obtaining suitable drainage outlets is a problem in many areas. Subsurface drainage tile placed in the sandy substratum is subject to clogging. Undrained areas are limited to marsh hay production during dry years.

The use of the soil for pasture is restricted to dry periods.

This soil is suitable for wood crops. Soil wetness and a high water table during the tree planting season limit reforestation to natural regeneration. The heavy equipment needed in harvesting can be used only when the soil is frozen. Clear-cut or area-selection harvest is needed to avoid a serious hazard of windthrow to the rest of the stand. Brushy species competing with natural regeneration can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is suited to construction of the dugout ponds and level ditches that provide shallow open water areas for waterfowl and muskrat production. The wetland vegetation provides suitable habitat for many wildlife species.

This soil is poorly suited as a septic tank absorption field and a building site because of the seasonal high water table and the frequent flooding.

The capability subclass is IVw. The woodland suitability subclass is 3w.

AtA—Atterberry silt loam, 0 to 3 percent slopes. This nearly level to gently sloping, somewhat poorly drained soil is on valley terraces and in drainageways of the uplands. It is subject to runoff from adjacent uplands. Areas are long and narrow or irregular in shape. They range from about 10 to 60 acres.

Typically, the surface layer of the Atterberry soil is very dark grayish brown silt loam about 9 inches thick. The subsurface layer is brown, very friable silt loam about 4 inches thick. The subsoil is about 39 inches thick. The upper part is dark yellowish brown and brown, mottled, friable silty clay loam. The middle part is grayish brown, mottled, friable and firm silty clay loam. The lower part is grayish brown, mottled, friable silt loam. The substratum to a depth of about 60 inches is grayish brown, mottled, very friable silt loam. In some areas the surface layer is lighter colored than is typical. In places this soil is poorly drained.

Included with this soil in mapping are small areas of Lomira soils and areas underlain by stratified silt and sand or sand and gravel. The well drained Lomira soils are in higher landscape positions. Some areas are underlain by limestone bedrock within a depth of 60 inches. Included areas make up 5 to 15 percent of this unit.

Permeability is moderate. Surface runoff is slow. Available water capacity is high. Reaction ranges from strongly acid to neutral in the subsoil and substratum. Shrink-swell potential is moderate in the subsoil.

Undrained areas of this soil are saturated for long periods at depths of 1 to 3 feet. The response to additions of plant nutrients in undrained areas is limited by the excessive wetness. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas of this soil are farmed. If drained, the soil has good potential for cultivated crops, hay, and pasture. Unless drained, it has only fair potential for crops. It has good potential for trees. It has fair to poor potential for recreational development and poor potential for most engineering uses.

If drained, this soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Grasses and legumes are subject to winterkill from ponding and ice sheeting. Yields on the undrained soil are limited by the excessive wetness. Surface and subsurface drainage is needed. Diversions on nearby uplands help to prevent ponding.

This soil can be used as pastureland or hayland. Overgrazing or grazing when the soil is wet, however, results in surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is poorly suited as a septic tank absorption field and a building site because of the seasonal high water table. If this soil is to be used as a building site, it should be drained and protected from runoff from adjacent uplands. Because the soil has low strength, dwellings should be constructed without basements and foundations and footings should be designed to provide the structural support needed. Local roads and streets should be graded to shed water if they are to function properly, and suitable base material should be added.

The capability subclass is IIw. The woodland suitability subclass is 2o.

BoB—Borth silty clay loam, 1 to 4 percent slopes. This nearly level to gently sloping, moderately well drained soil is on low ridges in lake basins. Areas are long and narrow or irregular in shape. They range from about 5 to 80 acres.

Typically, the surface layer of this Borth soil is dark brown silty clay loam about 8 inches thick. The subsoil is reddish brown, firm clay about 22 inches thick. The lower part is mottled. The substratum to a depth of about 60 inches is brown and pale brown, mottled fine and medium sand. In some areas the surface layer is silt loam or silty clay. In some it is lighter colored than is typical. In places the subsoil contains thin strata of sand. In some areas the substratum contains thin strata of silt or clay. In places this soil is wetter than is typical.

Included with this soil in mapping are small areas of Winneconne soils in landscape positions similar to those of the Borth soil. In contrast, those soils do not have sand within a depth of 40 inches. Also included are areas where the surface layer is loamy fine sand or clay. Included areas make up 5 to 10 percent of the unit.

Permeability is slow in the subsoil and rapid in the substratum. Surface runoff is slow or medium. Water ponds in swales and in low areas after excessive rainfall. Available water capacity is low to moderate. Reaction ranges from medium acid to moderately alkaline in the subsoil. The shrink-swell potential is high in the subsoil.

This soil is saturated for long periods at depths of 3 to 6 feet. Tilth is poor. The response to additions of plant nutrients is limited by the low available water capacity.

Most areas are farmed. A few small areas are wooded. The potential is fair for cultivated crops, hay, pasture, and trees. It is fair to poor for recreational development and most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. The

low available water capacity limits yields. The soil is difficult to work. It is sticky when wet and hard when dry. Seedbeds are difficult to prepare. Because the soil must be tilled at the proper moisture content to prevent clodding and soil compaction, tilling and harvesting are often delayed.

Timely conservation tillage reduces soil compaction and clodding. Returning crop residue or regularly adding manure improves tilth and increases the water-holding capacity and water infiltration. Legumes are subject to winterkill from ponding and ice sheeting. Surface or subsurface drainage is needed in many areas. Subsurface drainage tile in the sandy substratum is subject to clogging.

If the soil is used for pasture, overgrazing should be avoided. Grazing when the soil is wet results in compaction. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. Seedling survival can be improved by planting vigorous nursery stock. Brushy vegetation competing with natural regeneration following harvest can be controlled through the use of suitable herbicides, or the vegetation can be removed mechanically.

This soil is poorly suited as a septic tank absorption field and a building site because of the seasonal high water table and the slow permeability in the subsoil. If this soil is to be used as a site for dwellings with basements, it should be drained. Because of the low strength and the shrinking and swelling of the subsoil, foundations and footings should be designed to provide the structural support needed. Because the substratum flows if wet, sidewalls of excavations are likely to cave in. Local roads and streets should be graded to shed water if they are to function properly, and a suitable base material should be added.

The capability subclass is IIe. The woodland suitability subclass is 3c.

BrB—Brems fine sand, 1 to 4 percent slopes. This nearly level to gently sloping, moderately well drained soil is on stream and lake terraces and on low sand ridges in glacial lake basins. Areas are long and narrow or irregular in shape. They range from about 5 to 300 acres.

Typically, the surface layer of this Brems soil is very dark grayish brown fine sand about 8 inches thick. The subsoil is yellowish brown and strong brown fine sand about 33 inches thick. The lower part is mottled. The substratum to a depth of about 60 inches is pale brown mottled fine sand. It commonly is underlain by finer textured material within a depth of 7 feet. In places this soil is well drained.

Included with this soil in mapping are small areas underlain by loamy or clayey material within depths of 60 inches. These areas make up 5 to 15 percent of the unit.

Permeability is rapid. Surface runoff is very slow. Available water capacity is low. Reaction ranges from medium acid to very strongly acid in the subsoil.

This soil is saturated for long periods at depths of 2.5 to 3.5 feet. The response to additions of plant nutrients is limited by the low available water capacity and the acid soil conditions. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content.

Most areas are cropland and woodland. A few areas are planted to pine trees. This soil is a source of sand, and some areas are pits. The potential is poor for cultivated crops, hay, and pasture. It is good for irrigated crops if nutrients are added. It is fair for trees. The potential is poor for recreational development and fair to poor for most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Crop yields are limited by the low available water capacity. Some deep rooted plants may get sufficient moisture for good growth, but prolonged dry periods severely affect yields of all crops. Frequent liming of this very rapidly permeable soil is needed for good crop production. Cultivated areas are subject to severe soil blowing in dry periods if the soil is left bare and exposed.

Conservation tillage, winter cover crops, and spring plowing help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility, increases the water-holding capacity of the soil, and reduces soil blowing.

The use of the soil for pasture or hay is also effective in controlling soil blowing. Overgrazing, however, results in loss of the plant cover and increases the risk of blowing. Proper stocking, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. Seedling survival can be improved by planting vigorous nursery stock. Brushy vegetation competing with natural regeneration following harvest can be controlled through the use of suitable herbicides, or it can be removed mechanically.

This soil is poorly suited as a septic tank absorption field because of the seasonal high water table. If this soil is to be used as a site for dwellings with basements, it should be drained. Because the soil flows if wet and sloughs when dry, sidewalls of excavations are likely to cave in.

The capability subclass is IVs. The woodland suitability subclass is 3s.

CeB—Casco loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on broad crests of knolls. Areas are irregular in shape. They range from about 5 to 50 acres.

Typically, the surface layer of this Casco soil is dark grayish brown loam about 8 inches thick. The subsoil is about 13 inches thick. It is brown, friable loam in the upper part and reddish brown, friable clay loam in the

lower part. The substratum to a depth of about 60 inches is yellowish brown gravel and sand. In places the surface layer is silt loam. In some areas the subsoil dominantly is sandy loam. In places the subsoil is thicker than is typical.

Included with this soil in mapping are small areas underlain by loamy or clayey material within depths of 60 inches and areas where the surface layer is loamy fine sand or sandy loam. In places the subsoil is very thin or lacking and the surface layer is high in content of gravel. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the subsoil and very rapid in the substratum. Surface runoff is slow or medium. Available water capacity is low. Reaction ranges from slightly acid to mildly alkaline in the subsoil. Free lime occurs in the substratum. The shrink-swell potential is moderate in the subsoil.

The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. For many crops, root development is restricted below a depth of about 21 inches by the calcareous gravel and sand substratum. The response to additions of plant nutrients is limited by the low available water capacity.

Most areas of this soil are farmed. A few small areas are still wooded. The substratum is a good source of sand and gravel. There are many sand and gravel pits. The potential is fair for cultivated crops, hay, pasture, and trees. It is fair to good for recreational development and is good for most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Yields are limited by the low available water capacity. They are severely affected by prolonged dry periods and in eroded areas where there is no subsoil. Cobblestones and gravel interfere with tilling and harvesting in some areas. If the soil is cultivated, the erosion hazard is slight or moderate.

Conservation tillage, winter cover crops, spring plowing, and grassed waterways help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility and increases the water-holding capacity.

The use of the soil for pasture or hay is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction and excessive runoff. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. Survival of planted trees during dry seasons can be improved by planting vigorous nursery stock. Clear-cut or area-selection harvest reduces the risk of windthrow on the rest of the stand. Brushy species competing with natural regeneration following harvest can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is suited as a septic tank absorption field and a building site. There is a possible hazard of pollution of nearby water supplies from sewage effluent flowing through the substratum too rapidly for purification. Because the substratum is subject to sloughing, sidewalls of excavations are likely to cave in. Moderate frost action is a hazard to local roads and streets but can be corrected easily by removing the thin subsoil layer.

The capability subclass is IIIe. The woodland suitability subclass is 3s.

CeC2—Casco loam, 6 to 15 percent slopes, eroded. This sloping to moderately steep, well drained soil is on valley sides, knolls, and ridges. Areas are long and narrow or irregular in shape. They range from about 5 to 50 acres.

Typically, the surface layer of this Casco soil is dark grayish brown loam about 7 inches thick. The subsoil is mostly dark brown, friable loam and clay loam about 10 inches thick. The substratum to a depth of about 60 inches is yellowish brown gravel and sand. In some areas the surface layer is silt loam. In places the subsoil dominantly is sandy loam and is redder than is typical. In places slopes are more than 15 percent.

Included with this soil in mapping are small areas underlain by loamy or clayey material and areas where the surface layer is loamy fine sand or sandy loam. In places the subsoil is very thin or is lacking and the surface layer is high in content of gravel. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the subsoil and very rapid in the substratum. Surface runoff is medium. Available water capacity is low. Reaction ranges from slightly acid to mildly alkaline in the subsoil. Free lime occurs in the substratum. The shrink-swell potential is moderate in the subsoil.

The surface layer is erodible and is therefore a source of sedimentation. Cobblestones and gravel interfere with tillage in many areas. For many crops, root development is restricted below a depth of about 17 inches by the calcareous gravel and sand substratum. The response to additions of plant nutrients is limited by the low available water capacity.

Most areas of this soil are farmland and pasture, but some are woodland. The substratum is a good source of sand and gravel. There are some sand and gravel pits. The potential is fair for cultivated crops, hay, pasture, and trees. It is fair to poor for most recreational development and engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. The steeper areas should be restricted to hay or pasture. Yields are limited by the low available water capacity. They are severely affected by prolonged dry periods and by lack of a subsoil in eroded areas. Cobblestones and gravel interfere with tilling and harvesting in many areas. If the soil is cultivated, it is subject to further erosion.

Conservation tillage, spring plowing, winter cover crops, grassed waterways, and long rotations with only 1 year of a row crop help to prevent excessive soil loss. In

a few areas slopes are long enough and smooth enough to be farmed on the contour. Returning crop residue or regularly adding other organic material improves fertility and increases the water-holding capacity of the soil.

The use of the soil for pasture or hay is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction and excessive runoff. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. A few small areas are still in native hardwoods. Survival of planted trees during dry seasons can be improved by planting vigorous nursery stock. Clear-cut or area-selection harvest reduces the risk of windthrow to the rest of the stand. Brushy vegetation competing with natural regeneration following harvest can be controlled through the use of suitable herbicides, or it can be removed mechanically.

This soil is suited as a septic tank absorption field and a building site if proper design and installation procedures are used. Filter fields should be on the contour to prevent the effluent from surfacing. There is a possible hazard of polluting nearby water supplies by sewage effluent flowing through the substratum too rapidly for purification. Some leveling and land shaping are needed in preparing suitable building sites. Because the substratum is subject to sloughing, sidewalls of excavations are likely to cave in.

The capability subclass is IVe. The woodland suitability subclass is 3s.

Ed—Edwards muck. This nearly level, very poorly drained soil is in depressional and low areas next to lakes. It is subject to frequent flooding. Some areas are long and narrow. Some are broad. All range from about 40 to more than 300 acres.

Typically, the upper 18 inches of this Edwards soil is black muck. The next 5 inches is dark reddish brown muck. The substratum to a depth of 60 inches is gray, very friable marl with a few woody fragments. In places the organic material is less than 16 inches thick.

Included with this soil in mapping are small areas of Adrian, Houghton, and Palms soils in landscape positions similar to those of the Edwards soil. Adrian soils are underlain by sandy material, and Palms soils by loamy material. Houghton soils have no mineral soil within a depth of 51 inches. These areas make up 5 to 10 percent of the unit.

Permeability is moderately rapid. Surface runoff is very slow or ponded. Available water capacity is high. Reaction ranges from medium acid to mildly alkaline in the organic material.

Unless drained, this soil is saturated at or near the surface throughout most of the year. In undrained areas root development is restricted. The response to additions of plant nutrients in undrained areas is limited by excessive wetness. The surface layer is very friable and can be easily tilled when dry.

Most of the acreage is wetland vegetation, such as marsh grass, sedges, rushes, redosier brush, and cattails. A few areas are drained and are used for crops and grass sod. If drained, the soil has good potential for sod and some specialty crops and fair potential for cultivated crops. It has fair potential for trees. It has poor potential for recreational development and engineering uses.

This soil must be drained for dependable crop production. If drained, it is suited to corn and soybeans. It is generally not suited to small grain and to grasses and legumes for hay. The flood hazard and a short growing season, caused by frost late in spring and early in fall, limit yields and restrict the types of crops that can be grown. Soil blowing and subsidence are hazards if the soil is drained and cultivated.

Winter cover crops, controlled grazing, and restricted use when the soil is wet can help to minimize these hazards. Obtaining suitable drainage outlets is a problem in many areas. Undrained areas are limited to marsh hay production during dry years. The use of the soil for pasture is restricted to dry periods.

This soil is suitable for wood crops. Soil wetness and a high water table during the tree planting season limit reforestation to natural regeneration. The heavy equipment needed in harvesting can be used only when the soil is frozen. Clear-cut or area-selection harvest is needed to avoid a serious hazard of windthrow to the rest of the stand. Brushy species competing with natural regeneration can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is suited to construction of the dugout ponds and level ditches that provide shallow open water areas for waterfowl and muskrat production. The wetland vegetation provides suitable habitat for many wildlife species.

This soil is poorly suited as a septic tank absorption field and a building site because of the seasonal high water table and the frequent flooding.

The capability subclass is IVw. The woodland suitability subclass is 3w.

ElD2—Eleva loam, 8 to 20 percent slopes, eroded. This sloping to moderately steep, well drained soil is on valley sides. Sandstone outcrop is common. Areas are long and narrow and range from about 3 to 40 acres.

Typically, the surface layer of this Eleva soil is dark brown loam about 5 inches thick. The subsoil is about 16 inches thick. It is brown, friable loam in the upper part and strong brown, very friable fine sand in the lower part. Weakly cemented sandstone bedrock is at a depth of about 21 inches. At 41 inches is strongly cemented sandstone bedrock. Some areas have slopes of less than 8 percent or more than 20 percent.

Included with this soil in mapping are small areas where the depth to sandstone is less than 20 inches or more than 40 inches. In places the surface layer is loamy fine sand or fine sandy loam. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate or moderately rapid. Surface runoff is medium or rapid. Available water capacity is low. Reaction is medium acid or slightly acid in the subsoil.

The surface layer is erodible and is therefore a source of sedimentation. Tillage is restricted in many places by rock outcrop. Root development is restricted below a depth of about 21 inches by sandstone bedrock. The response to additions of plant nutrients is limited by the low available water capacity.

Most areas of this soil are cropland and permanent pasture. The underlying sandstone bedrock crushes easily and is an excellent source of industrial sand. The potential is fair for cultivated crops, hay, pasture, and trees. It is fair to poor for most recreational development and most engineering use.

Most areas of this soil are suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. The steeper areas should be restricted to pasture or hay and tilled only when tillage is needed in reseeding. Yields are limited by the low available water capacity. They are severely affected by prolonged dry periods. In places sandstone outcrop interferes with tilling and harvesting. Cultivated soil is subject to further erosion.

Conservation tillage, contour farming, spring plowing, winter cover crops, grassed waterways, and long rotations with only 1 year of a row crop help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility and increases the water-holding capacity.

The use of the soil as pastureland or hayland is effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction and excessive runoff. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. Soil-related management problems are associated with the steep slope and with brush encroachment following harvest. Contouring of planted trees and careful location of skid roads during harvest minimize erosion and improve the trafficability of equipment. Seedling survival on the steeper south- or west-facing slopes can be improved by planting vigorous nursery stock. Brushy species competing with natural regeneration following harvest can be controlled through the use of suitable herbicides, or they can be removed mechanically. Sufficient mineral soil may be exposed during skidding to allow adequate regeneration.

This soil is poorly suited as a septic tank absorption field because it is shallow over sandstone bedrock. There is a possible hazard of polluting nearby water supplies by sewage effluent flowing through the sandstone too rapidly for purification. This soil is moderately suited as a building site because of the slope and the shallowness over rock. Some leveling and land shaping are needed in preparing suitable building sites. The weakly cemented sandstone permits excavation and development in most areas.

The capability subclass is IIIe. The woodland suitability subclass is 3r.

FkA—Fisk loamy fine sand, 0 to 3 percent slopes. This nearly level to gently sloping, somewhat poorly drained soil is in glacial lake basins and beaches and on terraces of streams, lakes, and valleys. Areas are long and narrow or irregular in shape. They range from about 10 to several hundred acres.

Typically, the surface layer of this Fisk soil is very dark brown loamy fine sand about 9 inches thick. The subsoil is about 30 inches thick. It is brown, mottled fine and medium sand in the upper 15 inches. The middle part is light olive brown, mottled, very friable fine sandy loam. The lower part is grayish brown, mottled, friable silt loam. The substratum to a depth of about 60 inches is brown and pinkish gray, mottled, stratified, very friable silt loam and very fine sandy loam. In places the surface layer is fine sand. In places the upper sandy material is thicker than 40 inches. In places this soil is wetter than is typical.

Included with this soil in mapping are small areas of Nebago soils, which are underlain by clay within a depth of 40 inches. Included areas make up 2 to 5 percent of the unit.

Permeability is rapid in the upper sandy deposits and moderate in the underlying loamy material. Surface runoff is very slow. Available water capacity is moderate. Reaction ranges from strongly acid to neutral in the upper sandy deposits and slightly acid to mildly alkaline in the loamy subsoil material. Free lime occurs in the substratum.

Undrained areas of this soil are saturated for long periods at depths of 1 to 3 feet. The response to additions of plant nutrients in undrained areas is limited by the excessive wetness and the low available water capacity of the upper sandy deposits. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content.

Most areas are farmed. A few areas are still wooded. The soil has fair potential for cultivated crops, hay, pasture, and trees. It has fair to poor potential for recreational development and poor potential for most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. The excessive wetness and the low available water in the upper sandy material limit yields. Legumes are subject to winterkill from ponding and ice sheeting.

Surface and subsurface drainage is needed. Because the soil flows if wet, constructing and maintaining open-ditch drains is difficult. Subsurface tile drains are subject to clogging. In dry periods, the upper part of the soil is droughty and yields for most crops are severely affected. Some deep rooted plants may get sufficient moisture for good growth. Drained areas are subject to soil blowing in dry periods if the soil is left bare and exposed.

Conservation tillage, winter cover crops, and spring plowing help to prevent excessive soil loss. Returning

crop residue or regularly adding manure improves fertility, increases the water-holding capacity of the soil, and reduces soil blowing.

The use of the soil as pastureland or hayland is also effective in controlling soil blowing. Overgrazing, however, results in loss of the plant cover and increases the risk of blowing. Proper stocking, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species competing with natural regeneration can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is poorly suited as a septic tank absorption field and a building site because of the seasonal high water table. If used as a building site, it should be drained. Dwellings should be constructed without basements. Roads should be graded to shed water, and suitable base material should be added to help overcome the hazard of frost action.

The capability subclass is IIIw. The woodland suitability subclass is 3s.

Fn—Fluvaquents. These nearly level, poorly drained and very poorly drained soils are adjacent to streams. They are pitted and marked by old stream channels in some places. In other places, they consist of a series of slight rises separated by slightly lower swales. They are subject to frequent flooding. Areas are long and narrow or irregular in shape. They range from 20 to 200 acres. Slopes are 0 to 2 percent.

Fluvaquents vary in color and texture but are typically loam, fine sandy loam, or sandy loam intermixed with thin layers of sand, silt, or muck. In some places these soils are mostly one texture and lack distinct layering. In places the surface layer is muck.

Included with these soils in mapping are small areas of Adrian, Houghton, Kingsville, and Palms soils in landscape positions similar to those of the Fluvaquents. Adrian and Palms soils have 16 to 50 inches of organic material over mineral soil. Houghton soils are organic to a depth of more than 51 inches. Kingsville soils are sandy throughout. Also included are areas consisting mostly of clayey material. In places these soils are covered with 1 to 3 feet of water most of the year. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate. Surface runoff is very slow. Available water capacity is high.

These soils are saturated at or near the surface throughout most of the year. Root development is restricted. The response to additions of plant nutrients in undrained areas is limited by the excessive wetness and flooding.

Most areas of these soils are woodland or permanent pasture, or they are in wetland vegetation, such as marsh grasses, sedges, reeds, cattails, redosier, and alder brush. The soils have poor potential for crops and trees. If drained, they have fair potential for hay and pasture. They have poor potential for recreational development and engineering use.

These soils are generally not suited to cultivated crops. The excessive wetness and frequent flooding limit yields and restrict the types of crops that can be grown. Grasses and legumes are subject to winterkill from ponding and ice sheeting. Obtaining suitable drainage outlets is a problem in most areas. Grazing should be restricted to dry periods.

Dikes can help to prevent flooding from nearby streams. If drained, these soils are suited to grasses and legumes for hay and pasture.

These soils are poorly suited to wood crops. Growth is so slow and form so poor that trees are barely merchantable at best. Because of wetness, planting by hand or by machine on prepared ridges is needed when natural regeneration is unreliable. Large vigorous nursery stock is essential. The heavy equipment needed in harvesting can be used only when the soil is frozen. Clear-cut or area-selection harvest reduces the risk of windthrow to the rest of the stand. Brushy vegetation competing with natural regeneration can be controlled through the use of suitable herbicides, or it can be removed mechanically.

These soils are suited to construction of the dugout ponds and level ditches that provide shallow open water areas for waterfowl and muskrat. The wetland vegetation provides suitable habitat for many wildlife species.

These soils are generally not suited as a septic tank absorption field or a building site because of the hazard of frequent flooding. Suitable base material will have to be added if local roads and streets are to function properly.

The capability subclass is Vw. These soils are not assigned to a woodland suitability subclass.

FsB—Fox silt loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on convex side slopes of outwash plains and on high valley terraces. Areas are irregular in shape and range from 10 to 60 acres.

Typically, the surface layer of this Fox soil is dark grayish brown silt loam about 9 inches thick. The subsurface layer is brown silt loam about 2 inches thick. The subsoil is about 20 inches thick. The upper part is dark yellowish brown, very friable and friable silt loam and silty clay loam. The lower part is dark brown, friable loam and sandy clay loam. The substratum to a depth of about 60 inches is yellowish brown sand and gravel. In some areas the subsoil is redder than is typical. In places it is thinner or thicker than is typical. In places it is clay loam throughout.

Included with this soil in mapping are small knobs where the surface layer is high in content of gravel. In some areas the surface layer is loamy fine sand or fine sandy loam. Included areas make up 10 to 15 percent of the unit.

Permeability is moderate in the subsoil and rapid or very rapid in the substratum. Surface runoff is slow or medium. Available water capacity is moderate. Reaction ranges from medium acid to neutral in the subsoil. The shrink-swell potential is moderate in the subsoil. Free lime occurs in the substratum.

The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to crust or puddle after hard rains, especially where it contains subsoil material. In places cobblestones and gravel interfere with tillage. For many crops, root development is restricted below a depth of about 31 inches by the highly calcareous sand and gravel substratum.

Most areas of this soil are farmed. A few small areas are wooded. The substratum is a good source of sand and gravel. There are some sand and gravel pits. The potential is good for cultivated crops, hay, pasture, and trees. It is fair to good for recreational development and fair to poor for most engineering use.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Cobblestones and gravel interfere with tilling and harvesting in places. Cultivated areas are subject to a slight or moderate erosion hazard.

Conservation tillage, spring plowing, and grassed waterways can help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves the fertility and structure of the surface layer, reduces crusting, and increases water infiltration.

The use of this soil as pasture or hayland is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is suited as a septic tank absorption field. There is a possible hazard of polluting nearby water supplies by sewage effluent flowing through the substratum too rapidly for purification. Because of the low strength and the shrinking and swelling of the subsoil, buildings should have foundations and footings designed to provide the structural support needed. Because the substratum is subject to sloughing, sidewalls of excavations are likely to cave in. Local roads and streets are subject to failure as a result of low strength of the subsoil. Suitable base material will have to be added or the subsoil layer removed if roads are to function properly.

The capability subclass is IIe. The woodland suitability subclass is 2o.

FsC2—Fox silt loam, 6 to 12 percent slopes, eroded. This sloping, well drained soil is on valley sides, knolls, and ridges. Areas are long and narrow or irregular in shape. They range from about 5 to 30 acres.

Typically, the surface layer of this Fox soil is dark grayish brown silt loam about 7 inches thick. The subsoil is about 19 inches thick. The upper part is mainly dark yellowish brown, friable silty clay loam. The lower part is dark brown, friable loam and sandy clay loam. The substratum to a depth of about 60 inches is yellowish brown sand and gravel. In some areas the subsoil is dominantly sandy loam. In some areas it is redder than is typical. In places it is thinner than is typical.

Included with this soil in mapping are small areas where the surface layer is loamy fine sand. In places where the original surface layer and part of the subsoil have been lost through erosion, the surface layer is gravelly sandy loam or gravelly sandy clay loam. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the subsoil and rapid or very rapid in the substratum. Surface runoff is medium. Available water capacity is moderate. Reaction ranges from medium acid to neutral in the subsoil. Free lime occurs in the substratum. The shrink-swell potential is moderate in the subsoil.

The surface layer tends to crust after hard rains, especially where it contains subsoil material. Cobblestones and gravel interfere with tillage in some areas. For many crops, root development is restricted below a depth of about 26 inches by the highly calcareous sand and gravel substratum.

Most areas of this soil are farmed. A few small areas are wooded. The substratum is a good source of sand and gravel. There are some sand and gravel pits. The potential is fair for cultivated crops, hay, and pasture. It is good for trees. It is fair to poor for most recreational development and engineering use.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Cobblestones and gravel interfere with tilling and harvesting in some areas. Cultivated areas are subject to further erosion.

Long rotations with 1 year of a row crop, conservation tillage, winter cover crops, spring plowing, and grassed waterways help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility, reduces crusting, and increases water infiltration.

The use of the soil as pastureland or hayland is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is suited as a septic tank absorption field and a building site if proper design and installation proce-

dures are used. Filter fields should be on the contour to prevent the effluent from surfacing. There is a possible hazard of polluting nearby water supplies by sewage effluent flowing through the substratum too rapidly for purification. Because of the low strength and the shrinking and swelling of the subsoil, buildings should have foundations and footings designed to provide the structural support needed. Some leveling and land shaping are needed in preparing suitable building sites. Because the substratum is subject to sloughing, sidewalls of excavations are likely to cave in. Local roads and streets are subject to failure as a result of the low strength of the subsoil. Suitable base material will have to be added or the subsoil layer removed if roads are to function properly.

The capability subclass is IIIe. The woodland suitability subclass is 2o.

GnB—Grellton fine sandy loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on valley sides and broad moraines on till plains. Areas are irregular in shape. They range from about 5 to 40 acres.

Typically, the surface layer of this Grellton soil is dark grayish brown fine sandy loam about 8 inches thick. The subsurface layer is brown, very friable fine sandy loam about 5 inches thick. The subsoil is about 44 inches thick. It is dark brown, friable loam in the upper part. The middle part is dark yellowish brown and dark brown, friable silt loam. The lower part is dark brown, friable loam and very friable sandy loam. The substratum to a depth of about 60 inches is yellowish brown, very friable sandy loam. In places the surface layer is silt loam or loam.

Included with this soil in mapping are small areas of Plano soils in landscape positions similar to those of the Grellton soil. Plano soils have a thicker, darker colored surface layer and have less sand in the upper layers. Also included are areas where the surface layer is loamy fine sand. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate. Surface runoff is slow or medium. Available water capacity is high. Reaction ranges from slightly acid to strongly acid in the subsoil. Free lime occurs in the substratum.

Some areas are saturated for long periods at depths of 3 to 5 feet. The soil is erodible, especially in the more sloping areas, and is therefore a source of sedimentation. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content.

Most areas of this soil are farmed. The potential is good for cultivated crops, hay, pasture, and trees. It is fair to good for recreational development and fair to poor for most engineering use.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Cultivated areas are subject to a slight or moderate erosion hazard.

Conservation tillage, winter cover crops, spring plowing, and grassed waterways can help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility and reduces soil loss.

The use of the soil for pasture or hay is also effective in controlling erosion. Overgrazing, however, results in loss of the plant cover and in excessive runoff. Proper stocking, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is suited as a septic tank absorption field. Because of the low strength and the shrinking and swelling of the subsoil, buildings should have foundations and footings designed to provide the structural support needed. Local roads and streets should be graded to shed water if they are to function properly, and the subsoil layer should be strengthened or replaced with suitable base material.

The capability subclass is IIe. The woodland suitability subclass is 1o.

HmB—Hochheim loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on the broad crests of hills and ridges on till plains. It occurs at the highest positions on the landscape near large areas of the lower lying Kewaunee and Omro soils. Areas are long and broad or irregular in shape. They commonly are about 30 to 60 acres.

Typically, the surface layer of this Hochheim soil is very dark brown loam about 7 inches thick. The subsoil is about 9 inches thick. The upper part is dark reddish brown, friable loam. The lower part is reddish brown, very friable gravelly loam. The substratum to a depth of about 60 inches is light yellowish brown gravelly fine sandy loam. In places this soil is wetter than is typical. The surface layer is silt loam in some places.

Included with this soil in mapping are small areas of the Lorenzo Variant and Omro soils. The Lorenzo Variant is in landscape positions similar to those of the Hochheim soil. It has loamy material at a depth of 20 to 40 inches. Omro soils are slightly lower on the landscape. They have a thicker, more clayey subsoil. Also included are areas underlain by limestone bedrock within a depth of 60 inches. In places the surface layer is high in content of gravel. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate or moderately slow. Surface runoff is slow or medium. Available water capacity is moderate. Reaction is neutral or mildly alkaline in the subsoil. The shrink-swell potential is moderate in the subsoil. Free lime occurs in the substratum.

The surface layer is friable and can be easily tilled throughout a wide range in moisture content. Cobblestones and gravel interfere with tillage in some areas. For many crops, root development is restricted below a depth of about 16 inches by highly calcareous loamy till.

Most areas are farmed. A few small areas are still wooded. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to good potential for recreational development and engineering uses. It is a fair source of roadfill.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It becomes droughty during prolonged dry periods. Cobblestones and gravel interfere with tilling and harvesting in some areas. If cultivated, this soil is subject to a slight or moderate erosion hazard.

Conservation tillage, winter cover crops, spring plowing, and grassed waterways conserve moisture and help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility and increases the water-holding capacity.

The use of the soil for pasture or hay is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction and excessive runoff. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species can be controlled through the use of suitable herbicides, or they can be removed mechanically.

Areas of this soil that are moderately permeable are only moderately suited as septic tank absorption fields. Some areas are well suited. Areas that are moderately slowly permeable are poorly suited as septic tank absorption fields. Suitability can be improved by increasing the size of the absorption area. This soil is suited as a building site. It lacks sufficient strength to support vehicular traffic, but this can be easily corrected by strengthening or replacing the subsoil layer. Wet basements, a problem where permeability is moderately slow, can be corrected by installing tile drainage.

The capability subclass is IIe. The woodland suitability subclass is 2o.

HoB—Hortonville loamy fine sand, 2 to 6 percent slopes. This gently sloping, well drained soil is on convex hills and lower side slopes on till plains. Areas are irregular in shape. They range from about 5 to 100 acres.

Typically, the surface layer of this Hortonville soil is dark brown loamy fine sand about 9 inches thick. The subsoil is about 22 inches thick. The upper 5 inches is yellowish brown, very friable loamy fine sand. The lower part is reddish brown, firm clay loam and loam. The substratum to a depth of about 60 inches is reddish brown, friable loam. In some areas the sandy deposits are less than 10 inches thick. In some the lower part of the subsoil contains more clay than is typical.

Included with this soil in mapping are small areas of Nebago and Tustin soils. The somewhat poorly drained Nebago soils are in drainageways and depressions. They have a sandy surface layer 20 to 40 inches thick. Tustin soils are in landscape positions similar to those of the Hortonville soil. They have sandy deposits 20 to 40 inches thick. Some areas are underlain by limestone bedrock within a depth of 60 inches. Also included are areas where the surface layer is silt loam or, if eroded, clay loam. In places, layers of sand and gravel are in the subsoil and substratum. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate or moderately slow. Surface runoff is slow. Available water capacity is moderate to high. Reaction ranges from medium acid to neutral in the upper part of the subsoil and is neutral or mildly alkaline in the lower part. Free lime occurs in the lower part of the subsoil and in the substratum. The shrink-swell potential is moderate. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content.

Most areas are farmed. A few areas are still wooded. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair potential for recreational development and fair to poor potential for most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Cultivated areas are subject to soil blowing during dry periods if the soil is left bare and exposed.

Conservation tillage, winter cover crops, and spring plowing can help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility, increases the water-holding capacity of the surface layer, and reduces soil blowing.

The use of the soil for pasture or hay is also effective in controlling erosion. Overgrazing, however, results in loss of the plant cover and in soil blowing. Proper stocking, pasture rotation, and timely deferment of grazing can help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species can be controlled through the use of suitable herbicides, or they can be removed mechanically.

In areas where permeability is moderately slow, the soil is poorly suited as a septic tank absorption field. In areas where permeability is moderate, the soil is moderately suited as a septic tank absorption field. Suitability can be improved by increasing the size of the absorption area. Because of the low strength and the shrinking and swelling of the soil, dwellings should have foundations and footings designed to provide the structural support needed. Local roads and streets should be graded to shed water if they are to function properly, and a suitable base material should be added.

The capability subclass is IIe. The woodland suitability subclass is 1o.

HoC2—Hortonville loamy fine sand, 6 to 12 percent slopes, eroded. This sloping, well drained soil is

on hillsides on till plains. Areas are irregular in shape. They range from about 5 to 60 acres.

Typically, the surface layer of this Hortonville soil is dark brown loamy fine sand about 6 inches thick. The subsoil is about 21 inches thick. The upper 2 inches is yellowish brown, very friable loamy fine sand. The middle part is reddish brown, firm clay loam. The lower part is reddish brown, friable loam. The substratum to a depth of about 60 inches is reddish brown, friable loam. In some areas the sandy surface deposits are less than 10 inches thick. In some areas the lower part of the subsoil contains more clay than is typical.

Included with this soil in mapping are small areas where sandy deposits are 20 to 40 inches thick. Some areas are underlain by limestone bedrock within a depth of 60 inches. Also included are areas where the surface layer is silt loam. In places the sandy deposits have been eroded away, and the surface layer is loam or clay loam. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate or moderately slow. Surface runoff is slow or medium. Available water capacity is moderate or high. Reaction ranges from medium acid to neutral in the upper part of the subsoil and is neutral or mildly alkaline in the lower part. Free lime occurs in the lower part of the subsoil and in the substratum. The shrink-swell potential is moderate.

The surface layer is highly erodible and is therefore a source of sedimentation. Tilth is poor in eroded areas where the underlying loamy or clayey material has been exposed.

Most areas are farmed. A few are still wooded.

The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to poor potential for recreational development and engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Cultivated areas are subject to further erosion and to soil blowing during dry periods if the soil is left bare and exposed. Soil compaction and poor tilth are limitations in eroded areas.

Conservation tillage, winter cover crops, spring plowing, and grassed waterways can help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves tilth in eroded areas, increases the water-holding capacity of the surface layer, and reduces soil loss.

The use of the soil for pasture or hay is also effective in controlling erosion. Overgrazing, however, results in loss of the plant cover, in soil blowing, and in excessive runoff. Proper stocking, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species can be controlled through the use of suitable herbicides, or they can be removed mechanically.

In areas where permeability is moderately slow, the soil is poorly suited as a septic tank absorption field. In areas where permeability is moderate, the soil is moderately suited as a septic tank absorption field. Suitability in these areas can be improved by increasing the size of the absorption area. Filter fields should be on the contour to prevent the effluent from surfacing. Because of the low strength and the shrinking and swelling of the soil, dwellings should have foundations and footings designed to provide the structural support needed. Local roads and streets should be graded to shed water if they are to function properly, and a suitable base material should be added.

The capability subclass is IIIe. The woodland suitability subclass is 1o.

HrB—Hortonville silt loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on convex hills and lower side slopes on till plains. Areas are irregular in shape. They range up to several hundred acres.

Typically, the surface layer of this Hortonville soil is very dark grayish brown silt loam about 8 inches thick. The subsoil is about 20 inches thick. It is reddish brown, friable clay loam in the upper part. The lower part is reddish brown, friable loam. The substratum to a depth of about 60 inches is reddish brown, friable loam. In some places the surface layer is loam; in other places it is as much as 10 percent gravel. Some areas of this soil are eroded, and the subsoil is mixed in the plow layer. In some areas the subsoil and substratum contain more clay than is typical. In places this soil is wetter than is typical.

Included with this soil in mapping are small areas of the Lorenzo Variant in landscape positions slightly higher than those of the Hortonville soil. Also included are areas where the surface layer is loamy fine sand. In a few small areas, the substratum is fine sandy loam. Some areas are underlain by limestone bedrock within a depth of 60 inches. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate or moderately slow. Surface runoff is slow or medium. Water ponds in swales and in low areas after excessive rainfall. Available water capacity is high. Reaction ranges from medium acid to neutral in the upper part of the subsoil and is neutral or mildly alkaline in the lower part. Free lime occurs in the lower subsoil and substratum. The shrink-swell potential is moderate.

The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. It tends to crust or puddle after a hard rain, especially in areas where it contains subsoil material.

Most areas are farmed. A few are still wooded. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to good potential for recreational development. It has fair to poor potential for most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. In

eroded areas soil compaction and poor tilth are limitations. Deferment of tilling and harvesting is needed during wet periods. Cultivated areas are subject to a slight or moderate erosion hazard.

Conservation tillage, winter cover crops, spring plowing, diversions, and grassed waterways help to prevent excessive soil loss. Returning crop residue or regularly adding manure reduces crusting, improves tilth, and increases water infiltration.

The use of the soil for pasture or hay is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the soil and the pasture in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species can be controlled through the use of suitable herbicides, or they can be removed mechanically.

In areas where permeability is moderately slow, the soil is poorly suited as a septic tank absorption field. In areas where permeability is moderate, the soil is moderately suited as a septic tank absorption field. Suitability in these areas can be improved by increasing the size of the absorption area. Because of the low strength and the shrinking and swelling of the soil, dwellings should have foundations and footings designed to provide the structural support needed. Local roads and streets should be graded to shed water if they are to function properly, and a suitable base material should be added.

The capability subclass is IIe. The woodland suitability subclass is 1o.

HrC2—Hortonville silt loam, 6 to 12 percent slopes, eroded. This sloping, well drained soil is on the sides and crests of hills on till plains. Areas are long and narrow. They range from about 5 to 50 acres.

Typically, the surface layer of this Hortonville soil is dark brown silt loam about 7 inches thick. The subsoil is reddish brown, friable clay loam about 19 inches thick. The substratum to a depth of about 60 inches is reddish brown, friable loam. In some places the surface layer is loam. In other places it is as much as 10 percent gravel. In many places the original surface layer and all or part of the subsoil have been lost by erosion, and the plow layer is clay loam. In some areas the subsoil and substratum contain more clay than is typical. In some areas slopes are greater than 12 percent.

Included with this soil in mapping are small areas of the Lorenzo Variant, which is commonly in slightly higher landscape positions than those of the Hortonville soil and has a layer of sand and gravel above a depth of 40 inches. Also included are areas where the surface layer is loamy fine sand and some areas where limestone bedrock is within a depth of 60 inches. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate or moderately slow. Surface runoff is medium. Available water capacity is high. Reaction ranges from medium acid to neutral in the upper part of the subsoil and is neutral or mildly alkaline in the lower part. Free lime occurs in the lower part of the subsoil and in the substratum. The shrink-swell potential is moderate.

The surface layer tends to crust after heavy rain. It is a source of sedimentation in lower areas. Tilth is poor in eroded areas.

Most areas are farmed. A few small areas are still wooded. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair or poor potential for most recreational development and most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. In eroded areas, soil compaction and poor tilth are limitations. Deferment of tilling and harvesting is needed during wet periods. Cultivated areas are subject to further erosion. Conservation tillage, winter cover crops, spring plowing, and grassed waterways help to prevent excessive soil loss.

In some areas slopes are long enough and smooth enough to be farmed on the contour. Diversions can break slope length. Returning crop residue or regularly adding manure reduces crusting, improves tilth, and increases water infiltration.

The use of the soil for pasture or hay is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species can be controlled through the use of suitable herbicides, or they can be removed mechanically.

In areas where permeability is moderately slow, the soil is poorly suited as a septic tank absorption field. In areas where permeability is moderate, the soil is moderately suited as a septic tank absorption field. Suitability in these areas can be improved by increasing the size of the absorption area. Filter fields should be on the contour to prevent the effluent from surfacing. Because of the low strength and the shrinking and swelling of the soil, dwellings should have foundations and footings designed to provide the structural support needed. Local roads and streets should be graded to shed water if they are to function properly, and suitable base material should be added.

The capability subclass is IIIe. The woodland suitability subclass is 1o.

Hu—Houghton muck. This nearly level, very poorly drained soil is in depressions of old lake basins. It is subject to frequent flooding. Areas are long or irregularly shaped. They commonly are 80 to 400 acres, but range from 10 to 1,000 acres.

Typically, the surface layer of this Houghton soil is very dark brown muck about 3 inches thick over about 19 inches of black muck. The black muck is underlain by dark brown muck that extends to a depth of about 60 inches. Small areas have thick peat layers at depths of 3 to 5 feet.

Included with this soil in mapping are small areas of Adrian, Palms, and Willette soils. All are in landscape positions similar to those of the Houghton soil, but they are underlain by mineral soil at depths of 16 to 50 inches. Some areas adjacent to streams and lakes are covered with 1 to 3 feet of water most of the year. In some areas adjacent to uplands as much as 30 inches of silty sediment has been deposited by runoff from the uplands. In places in the Rush Lake area, the muck is underlain by limestone bedrock. Included areas make up 5 to 15 percent of the unit.

Permeability is moderately rapid. Surface runoff is very slow or ponded. Available water capacity is very high. Reaction ranges from medium acid to mildly alkaline.

Unless drained, this soil is saturated at or near the surface throughout most of the year. In undrained areas root development is restricted. The response to addition of plant nutrients in undrained areas is limited by the excessive wetness. The surface layer is very friable and can be easily tilled when dry.

Most of the acreage is in woodland and wetland vegetation, such as marsh grasses, sedges, reeds, cattails, and redosier brush. A few areas are drained and are used for crops and grass sod. The potential is good for sod and some specialty crops and fair for cultivated crops and trees. It is poor for recreational development and engineering uses.

This soil must be drained for dependable crop production. If drained, it is suited to corn and soybeans. It is generally not suited to small grain and to grasses and legumes for hay. The flood hazard and a short growing season, caused by frost late in spring and early in fall, limit yields and restrict the types of crops that can be grown. Soil blowing and subsidence are hazards if the soil is drained and cultivated.

Winter cover crops, controlled drainage, and restricted use when the soil is wet can help to minimize these hazards. Obtaining suitable drainage outlets is a problem in many areas. Undrained areas are limited to marsh hay production during dry years. The use of the soil for pasture is restricted to dry periods.

This soil is suitable for wood crops. Soil wetness and a high water table during the tree planting season limit reforestation to natural regeneration. The heavy equipment needed in harvesting can be used only when the soil is frozen. Clear-cut or area-selection harvest is needed to avoid a serious hazard of windthrow to the rest of the stand. Brushy species competing with natural regeneration can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is suited to construction of dugout ponds and level ditches that provide shallow open water areas for waterfowl and muskrat production. The wetland vegetation provides suitable habitat for many wildlife species.

This soil is poorly suited as a septic tank absorption field and a building site because of the seasonal high water table and the frequent flooding.

The capability subclass is IIIw. The woodland suitability subclass is 3w.

Hw—Houghton muck, ponded. This level, very poorly drained soil is in flooded areas adjacent to streams and lakes and is covered with 1 to 3 feet of water throughout the year. Areas are long or irregularly shaped. They commonly are 40 to 100 acres but range from 10 to 1,000 acres.

Typically, the surface layer of this Houghton soil is very dark brown muck about 3 inches thick over about 19 inches of black muck. The black muck is underlain by dark brown muck that extends to a depth of about 60 inches. Some areas have thick peat layers at a depth of 3 to 5 feet.

Included with this soil in mapping are small areas of Adrian, Houghton, Palms, and Willette soils. They are in landscape positions similar to those of the ponded Houghton soil but are not covered with 1 to 3 feet of water for such an extended period. Adrian, Palms, and Willette soils are underlain by mineral soils at a depth of 16 to 50 inches. These areas make up 5 to 15 percent of the unit.

The ponded Houghton soil is generally not suited to crops or any type of development. Drainage is not feasible unless a system of dikes and pumps is installed. The plant cover is mostly cattails. The soil provides suitable wildlife habitat and is used extensively by ducks, muskrats, and nongame birds. It also provides winter habitat for pheasant.

The capability subclass is VIIIw. The soil is not assigned to a woodland suitability subclass.

KaB—Kaukauna silty clay loam, 1 to 4 percent slopes. This nearly level to gently sloping, moderately well drained soil is on terraces in old lake basins. Areas are oblong or irregular in shape. They range from about 10 to 80 acres.

Typically, the surface layer of this Kaukauna soil is very dark brown silty clay loam about 9 inches thick. The subsurface layer is brown silty clay about 3 inches thick. The subsoil is about 36 inches thick. The upper part is reddish brown, firm clay. The middle part is reddish brown, firm silty clay. The lower part is dark brown, mottled, friable silt loam and loam. The substratum to a depth of about 60 inches is dark yellowish brown and brown, mottled, stratified very fine sand and silt. In some areas the surface layer is silt loam. In places the substratum contains thin layers of gravel or thin strata of clay. In some areas the substratum is loam glacial till with some pebbles and stones. In places this soil is wetter than is typical.

Included with this soil in mapping are small areas of Borth and Winneconne soil in landscape positions similar

to those of the Kaukauna soil. Both soils are underlain by sand at a depth of 20 to 40 inches. Winneconne soils have no loamy sediment within a depth of 40 inches. In places the surface layer is loamy fine sand or silty clay. Included areas make up 5 to 15 percent of the unit.

Permeability is slow or very slow. Surface runoff is slow or medium. Water ponds in swales and in low areas after excessive rainfall. Available water capacity is moderate or high. Reaction ranges from medium acid to mildly alkaline in the upper part of the subsoil and is neutral to moderately alkaline in the lower part. The shrink-swell potential is high in the upper part of the subsoil. Free lime occurs in the lower part of the subsoil and in the substratum.

This soil is saturated for long periods at depths of 3 to 5 feet. Tilth is poor.

Most areas are farmed. A few small areas are still wooded. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to poor potential for recreational development and poor potential for most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It is difficult to work. It is sticky when wet and hard when dry. Seedbeds are difficult to prepare. The soil must be tilled at the proper moisture content to prevent clodding and soil compaction. Wetness often delays tilling and harvesting.

Timely conservation tillage reduces the risk of soil compaction and clodding. Returning crop residue or regularly adding manure improves tilth and increases water infiltration. Legumes are subject to winterkill from ponding and ice sheeting. Surface or subsurface drainage is needed in many areas. Subsurface drainage tile in the substratum is subject to clogging.

If the soil is used for pasture, overgrazing should be avoided. Grazing when the soil is wet results in surface compaction. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. Seedling survival can be improved by planting vigorous nursery stock. Brushy vegetation competing with natural regeneration following harvest can be controlled through the use of suitable herbicides, or it can be removed mechanically.

This soil is poorly suited as a septic tank absorption field because of the seasonal high water table and the slow or very slow permeability in the upper part of the subsoil. It is poorly suited as a building site. Soil areas used as sites for dwellings with basements should be drained. Because of the low strength and the shrinking and swelling of the upper part of the subsoil, foundations and footings should be designed to provide the structural support needed. Local roads and streets should be graded to shed water if they are to function properly, and a suitable base material should be added.

The capability subclass is IIe. The woodland suitability subclass is 2c.

Ke—Keowns silt loam. This nearly level, poorly drained soil is in depressional areas and upland drainageways. It is subject to frequent flooding or ponding. Areas are long and narrow or irregular in shape. They range from about 10 to 200 acres.

Typically, the surface layer of this Keowns soil is black silt loam about 8 inches thick. The subsoil is olive gray, mottled, friable silt loam about 17 inches thick. The substratum to a depth of about 60 inches is brown and yellowish brown, mottled, very friable stratified fine sand and silt loam. In some areas this soil contains thin layers of gravel. Some areas have a surface layer of muck less than 16 inches thick. In places the surface layer is loam or very fine sandy loam.

Included with this soil in mapping are small areas of Wauseon soils and areas underlain by sand and gravel at depths of 40 to 60 inches. Wauseon soils are underlain by loamy or silty glacial till at a depth of 20 to 40 inches. In some areas the surface layer is silty clay loam. Included areas make up 5 to 10 percent of the unit.

Permeability is moderate. Surface runoff is very slow or ponded. Available water capacity is high. Reaction is neutral or mildly alkaline in the subsoil. Free lime occurs in the lower part of the subsoil and in the substratum.

Undrained areas are saturated within 1 foot of the surface for long periods. In undrained areas root development is restricted below a depth of about 1 foot. The response to additions of plant nutrients in undrained areas is limited by the excessive wetness. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most of the acreage is farmland or woodland, or it is in wetland vegetation, such as marsh grasses, sedges, and reeds. The potential is good for cultivated crops, hay, pasture, and trees. It is poor for recreational development and engineering uses.

Surface and subsurface drainage is needed. Diversions on nearby uplands can help to prevent ponding. If drained, this soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Grasses and legumes are subject to winterkill from ponding and ice sheeting. In undrained areas yields are limited by the excessive wetness. Obtaining suitable drainage outlets is a problem in many areas. Subsurface drainage tile is subject to clogging.

This soil is suitable for wood crops. Soil wetness generally requires planting by hand or machine on prepared ridges when natural regeneration is unreliable. Large vigorous nursery stock is essential to avoid mortality. The heavy equipment needed in harvesting can be used only when the soil is frozen. Clear-cut or area-selection harvest reduces the risk of windthrow to the rest of the stand. Brushy vegetation competing with natural regeneration can be controlled through the use of suitable herbicides, or it can be removed mechanically.

This soil is suited to construction of dugout ponds and level ditches that provide shallow open water areas. If wet, the soil flows and ponds and sidewalls of excavations cave in.

This soil is poorly suited as a septic tank absorption field and a building site because of the seasonal high water table and the flood hazard. If used as a building site, it must be drained and protected from flooding. Dwellings should be constructed without basements. If local roads and streets are to function properly, suitable base material should be added.

The capability subclass is IIIw. The woodland suitability subclass is Iw.

KmB—Kewaunee loamy fine sand, 2 to 6 percent slopes. This gently sloping, well drained and moderately well drained soil is on convex hills and lower side slopes. Areas are irregular in shape. They range from about 5 to 100 acres.

Typically, the surface layer of this Kewaunee soil is dark brown loamy fine sand about 8 inches thick. The subsoil is about 28 inches thick. The upper 7 inches is brown, very friable loamy fine sand. The lower part is mostly reddish brown, firm clay and silty clay loam. The substratum to a depth of about 60 inches is reddish brown, firm silty clay loam. In places the sandy deposits are less than 10 inches thick.

Included with this soil in mapping are small areas of Nebago and Tustin soils. The somewhat poorly drained Nebago soils are in drainageways and depressions. They have a sandy deposit 20 to 40 inches thick. Tustin soils are in landscape positions similar to those of the Kewaunee soil. They have 20 to 40 inches of sandy deposit over loamy or clayey material. Also included are areas where the surface layer is silt loam or, in some eroded areas, clay loam, commonly where convex slopes are 4 to 6 percent. Included areas make up 5 to 15 percent of the unit.

Permeability is moderately slow or slow. Surface runoff is slow. Available water capacity is moderate. Reaction ranges from medium acid to mildly alkaline in the subsoil. Free lime occurs in the lower part of the subsoil and in the substratum. The shrink-swell potential is moderate.

In many places this soil is saturated for long periods at depths of 3 to 6 feet. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content.

Most areas are farmed. A few small areas are still wooded. The soil has good potential for cultivated crops, hay, pasture, and trees. It has poor potential for recreational development and fair to poor potential for most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Cultivated areas are subject to soil blowing in dry periods if the soil is left bare and exposed.

Conservation tillage, winter cover crops, and spring plowing help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility, increases the water-holding capacity of the surface layer, and reduces soil blowing.

The use of the soil for pasture or hay is also effective in controlling erosion. Overgrazing, however, results in loss of the plant cover and in soil blowing. Proper stocking, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. Seedling survival can be improved by planting vigorous nursery stock. Brushy vegetation competing with natural regeneration following harvest can be controlled through the use of suitable herbicides, or it can be removed mechanically.

This soil is poorly suited as a septic tank absorption field because of moderately slow or slow permeability. It is also poorly suited as a building site. Because of the low strength of the soil, buildings should have foundations and footings designed to provide the structural support needed. Areas saturated at depths of 3 to 6 feet and used as sites for dwellings with basements should be drained. Local roads and streets should be graded to shed water if they are to function properly, and suitable base material should be added.

The capability subclass is IIe. The woodland suitability subclass is 2c.

KnB—Kewaunee silt loam, 2 to 6 percent slopes. This gently sloping, well drained and moderately well drained soil is on convex hills and lower side slopes. Most areas are dissected and separated by drainageways and depressions that contain the wetter Manawa and Poygan soils. Areas are irregular in shape. They range up to several hundred acres.

Typically, the surface layer of the Kewaunee soil is very dark grayish brown silt loam about 8 inches thick. The subsurface layer is brown silt loam about 2 inches thick. The subsoil is mostly reddish brown, firm clay about 19 inches thick. The substratum to a depth of about 60 inches is reddish brown, firm silty clay loam. In eroded areas where the subsoil has been mixed with the surface layer by plowing, the surface layer contains more clay than is typical. In some areas the subsoil and substratum contain less clay than is typical. In places this soil is wetter than is typical.

Included with this soil in mapping are small areas of Omro soils, commonly in landscape positions higher than those of the Kewaunee soil. They also differ in having more sand and less clay in the substratum. In some areas the surface layer is loamy fine sand, loam, or gravelly loam. In places it is underlain by a few inches of sand and gravel. Also included are small areas underlain by limestone bedrock within a depth of 60 inches. Included areas make up 5 to 15 percent of the unit.

Permeability is moderately slow or slow. Surface runoff is slow or medium. Water ponds in swales and in low areas after excessive rainfall. Available water capacity is moderate. Reaction ranges from medium acid to mildly alkaline in the subsoil. The substratum is mildly or moderately alkaline. Free lime occurs in the lower part of the subsoil and in the substratum. The shrink-swell potential is moderate.

In many places this soil is saturated for long periods at depths of 3 to 6 feet. A large acreage must be tilled at

the proper moisture content, especially in eroded areas where the plow layer contains subsoil material. If worked when wet, the surface layer compacts and dries into hard clods. These small eroded areas, commonly on convex slopes of 4 to 6 percent scattered throughout the unit, control time of tillage for the entire field.

Most areas are farmed. A few small areas are still wooded. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to good potential for recreational development. It has poor potential for most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Deferment of tilling and harvesting is needed during wet periods to prevent surface compaction and poor tilth. Cultivated areas are subject to a slight erosion hazard.

Conservation tillage, winter cover crops, spring plowing, diversions, and grassed waterways help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility, the structure of the surface layer, and tilth and increases water infiltration.

The use of the soil for pasture or hay is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction, poor tilth, and excessive runoff. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. Seedling survival can be improved by planting vigorous nursery stock. Brushy vegetation competing with natural regeneration following harvest can be controlled through the use of suitable herbicides, or it can be removed mechanically.

This soil is poorly suited as a septic tank absorption field because of moderately slow or slow permeability. It is also poorly suited as a building site. Because of the low strength of the soil, buildings should have foundations and footings designed to provide the structural support needed. Soil areas saturated at depths of 3 to 6 feet and used as sites for dwellings with basements should be drained. Local roads and streets should be graded to shed water if they are to function properly, and a suitable base material should be added.

The capability subclass is IIe. The woodland suitability subclass is 2c.

KoC2—Kewaunee silty clay loam, 6 to 12 percent slopes, eroded. This sloping, well drained soil is on the sides of moraines and hills. Areas are long and narrow. They range from about 5 to 60 acres.

Typically, the surface layer of this Kewaunee soil is dark brown silty clay loam about 7 inches thick. The subsoil is about 20 inches thick. It is reddish brown, firm clay in the upper part and silty clay in the lower part. The substratum to a depth of about 60 inches is reddish brown, firm silty clay loam. In some areas the subsoil and substratum contain less clay than is typical. In some areas slopes are greater than 12 percent. In places the surface layer is silt loam or loam.

Included with this soil in mapping are areas underlain by limestone bedrock or brownish loamy till within a depth of 60 inches. In some areas the surface layer is silty clay or loamy fine sand. Included areas make up 5 to 15 percent of the unit.

Permeability is moderately slow or slow. Surface runoff is medium. Available water capacity is moderate. Reaction ranges from medium acid to mildly alkaline in the subsoil. Free lime occurs in the lower part of the subsoil and in the substratum. The shrink-swell potential is moderate. Tilth is poor.

Most areas of this soil are farmed. A few small areas are still wooded. The potential is good for cultivated crops, hay, pasture, and trees. It is fair to poor for recreational development and poor for most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. It is difficult to work. It is sticky when wet and hard when dry. Seedbeds are difficult to prepare. The soil must be worked at the proper moisture content to prevent clodding and surface compaction. Wetness often delays tilling and harvesting. Cultivated areas are subject to further erosion.

Timely conservation tillage can help to reduce clodding and soil compaction and to prevent excessive soil loss. Winter cover crops, spring plowing, and grassed waterways also help to reduce the risk of erosion. In some areas slopes are long enough and smooth enough to be farmed on the contour. Diversions can break slope length. Returning crop residue or regularly adding manure improves tilth and increases water infiltration.

The use of the soil as pastureland or hayland is also effective in controlling erosion. Overgrazing when the soil is wet, however, results in surface compaction and excessive runoff. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. Seedling survival can be improved by planting vigorous nursery stock. Brushy vegetation competing with natural regeneration following harvest can be controlled through the use of suitable herbicides, or it can be removed mechanically.

This soil is poorly suited as a septic tank absorption field because of moderately slow or slow permeability. It is also poorly suited as a building site. Because of the low strength of the soil, buildings should have foundations and footings designed to provide the structural support needed. If local roads and streets are to function properly, suitable base material should be added.

The capability subclass is IIIe. The woodland suitability subclass is 2c.

KpB—Kidder loamy fine sand, 2 to 6 percent slopes. This gently sloping, well drained soil is on valley sides and low hills and ridges. Areas are irregular in shape. They range from about 10 to 250 acres.

Typically, the surface layer of this Kidder soil is dark brown loamy fine sand about 8 inches thick. The subsoil

is about 21 inches thick. The upper 3 inches is dark yellowish brown, friable loamy fine sand. The rest is dark brown clay loam and sandy clay loam. The substratum to a depth of about 60 inches is brown, very friable fine sandy loam. In places the sandy material is thicker than is typical. In some areas the surface layer is sandy loam.

Included with this soil in mapping are areas underlain by limestone bedrock within a depth of 60 inches. In some areas, the surface layer is silt loam. Included areas make up 5 to 10 percent of the unit.

Permeability is moderate. Surface runoff is slow. Available water capacity is moderate. Reaction ranges from medium acid to mildly alkaline in the subsoil. Free lime occurs in the substratum. The shrink-swell potential is moderate in the subsoil. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content.

Most areas of this soil are farmed. A few small areas are still wooded. The potential is good for cultivated crops, hay, pasture, and trees. It is fair for recreational development and fair to poor for most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Cultivated areas are subject to soil blowing in dry periods if the soil is left bare and exposed.

Conservation tillage, winter cover crops, and spring plowing help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility, increases the water-holding capacity of the surface layer, and reduces soil blowing.

The use of the soil as pastureland or hayland is also effective in controlling erosion. Overgrazing, however, results in loss of the plant cover and in soil blowing. Proper stocking, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is suited as a septic tank absorption field. It is suited as a building site if proper design procedures are used. Because of the shrinking and swelling of the subsoil, buildings should have foundations and footings designed to provide the structural support needed. If local roads and streets are to function properly, the subsoil layer should be replaced or covered with a suitable base material.

The capability subclass is IIe. The woodland suitability subclass is 2o.

KpC2—Kidder loamy fine sand, 6 to 12 percent slopes, eroded. This sloping, well drained soil is on valley sides and on the sides and crests of upland hills. Areas are long and narrow. They range from about 5 to 20 acres.

Typically, the surface layer is dark brown loamy fine sand about 8 inches thick. The subsoil is about 20 inches thick. The upper 2 inches is yellowish brown, very friable loamy fine sand. The lower 18 inches is dark brown, friable sandy clay loam and sandy loam. The substratum to a depth of about 60 inches is brown, very friable fine sandy loam.

Included with this soil in mapping are areas underlain by limestone bedrock within a depth of 60 inches. In some areas the surface layer is silt loam. In places the sandy deposits have been eroded away, and the surface layer is sandy clay loam or sandy loam. In these eroded areas the surface layer commonly contains gravel. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate. Surface runoff is slow or medium. Available water capacity is moderate. Reaction ranges from medium acid to mildly alkaline in the subsoil. Free lime occurs in the substratum. The shrink-swell potential is moderate in the subsoil.

The surface layer is highly erodible and is therefore a source of sedimentation. Cobblestones and gravel interfere with tillage in some areas.

Most areas of this soil are farmed. A few small areas are still wooded. The potential is fair for cultivated crops, hay, and pasture. It is good for trees. It is fair to poor for recreational development and engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Cultivated areas are subject to further erosion and also to soil blowing in dry periods if the soil is left bare and exposed.

Conservation tillage, winter cover crops, spring plowing, and grassed waterways help to reduce excessive soil loss. In some areas, slopes are long enough and smooth enough to be farmed on the contour. Returning crop residue or regularly adding manure improves fertility, increases the water-holding capacity of the surface layer, and reduces soil loss.

The use of the soil as pastureland or hayland is also effective in controlling erosion. Overgrazing, however, results in loss of the plant cover, in soil blowing, and in excessive runoff. Proper stocking, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is suited as a septic tank absorption field and a building site if proper design and installation procedures are used. Filter fields should be on the contour to prevent the effluent from surfacing. Because of the shrinking and swelling of the subsoil, buildings should have foundations and footings designed to provide the structural support needed. Some leveling and land shaping are needed in preparing suitable building sites. If local roads and streets are to function properly, the subsoil layer should be replaced or covered with suitable base material.

The capability subclass is IIIe. The woodland suitability subclass is 2o.

KrB—Kidder silt loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on valley sides and on low hills and ridges. Areas are irregular in shape. They range from about 10 to 80 acres.

Typically, the surface layer of this Kidder soil is very dark grayish brown silt loam about 8 inches thick. The subsoil is about 30 inches thick. The upper part is dark brown, friable clay loam, and the lower part is sandy clay loam. The substratum to a depth of about 60 inches is yellowish brown, very friable fine sandy loam. In places this soil is wetter than is typical.

Included with this soil in mapping are areas underlain by limestone bedrock within a depth of 60 inches. In some areas the surface layer is loamy fine sand. Included areas make up 5 to 10 percent of the unit.

Permeability is moderate. Surface runoff is slow or medium. Available water capacity is moderate. Reaction ranges from medium acid to mildly alkaline in the subsoil. Free lime occurs in the substratum. The shrink-swell potential is moderate in the subsoil. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas are farmed. A few small areas are still wooded. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to good potential for recreational development and fair to poor potential for most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If used for cultivated crops, it is subject to a slight or moderate erosion hazard.

Conservation tillage, winter cover crops, spring plowing, and grassed waterways help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility and increases water infiltration.

The use of the soil as pastureland or hayland is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction and excessive runoff. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is suited as a septic tank absorption field. It is suited as a building site if proper design procedures are used. Because of the shrinking and swelling of the subsoil, buildings should have foundations and footings designed to provide the structural support needed. If local roads and streets are to function properly, the subsoil layer should be replaced or covered with a suitable base material.

The capability subclass is IIe. The woodland suitability subclass is 2o.

KrC2—Kidder silt loam, 6 to 15 percent slopes, eroded. This sloping to moderately steep, well drained soil is on valley sides and on hills and ridges. Areas commonly are long and narrow. They range from about 10 to 50 acres.

Typically, the surface layer of this Kidder soil is very dark grayish brown silt loam about 7 inches thick. The subsoil is about 25 inches thick. The upper part is mostly dark brown, friable loam. The middle part is sandy clay loam. The lower part is dark brown, friable sandy loam. The substratum to a depth of about 60 inches is yellowish brown, very friable fine sandy loam. In places the surface layer is loam or sandy clay loam. In some areas slopes are more than 15 percent.

Included with this soil in mapping are areas underlain by limestone bedrock within a depth of 60 inches. In some areas the surface layer is loamy fine sand. In some eroded areas the surface layer contains gravel. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate. Surface runoff is medium. Available water capacity is moderate. Reaction ranges from medium acid to mildly alkaline in the subsoil. Free lime occurs in the substratum. The shrink-swell potential is moderate in the subsoil.

The surface layer tends to crust after heavy rain. It is a source of sedimentation to lower areas. Cobblestones and gravel interfere with tillage in some areas.

Most areas of this soil are farmed. A few small areas are still wooded. The potential is good for cultivated crops, hay, pasture, and trees. It is fair or poor for most recreational development and most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Cobblestones and gravel interfere with tilling and harvesting in some areas. If the soil is used for cultivated crops, it is subject to further erosion.

Long rotations with 1 year of a row crop, conservation tillage, spring plowing, winter cover crops, diversions, and grassed waterways help to prevent excessive soil loss. In some areas slopes are long enough and smooth enough to be farmed on the contour. Returning crop residue or regularly adding manure improves fertility and increases water infiltration.

The use of the soil as pastureland or hayland is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction and excessive runoff. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is suited as a septic tank absorption field and a building site if proper design and installation procedures are used. Filter fields should be on the contour to prevent the effluent from surfacing. Because of the

shrinking and swelling of the subsoil, buildings should have foundations and footings designed to provide the structural support needed. Some leveling and land shaping are needed. If local roads and streets are to function properly, the subsoil layer should be replaced or covered with suitable base material.

The capability subclass is IIIe. The woodland suitability subclass is 2o.

Ks—Kingsville mucky loamy fine sand. This nearly level, very poorly drained soil is in depressional areas of outwash plains and glacial lake basins. It is subject to frequent flooding. Areas are long and narrow or irregular in shape. They range from about 5 to 60 acres.

Typically, the surface layer of this Kingsville soil is black mucky loamy fine sand about 7 inches thick. The subsoil is mottled fine sand about 19 inches thick. The upper part is dark gray. The lower part is grayish brown. The substratum to a depth of about 60 inches is brown fine sand. In some areas this soil contains thin strata of loamy or clayey deposits. In some areas the surface layer is muck or fine sandy loam.

Included with this soil in mapping are small areas of Adrian soils in landscape positions similar to those of the Kingsville soil. Adrian soils have an organic layer 16 to 50 inches thick over sandy deposits. Also included are areas underlain by loamy or clayey material within a depth of 60 inches. Included areas make up 5 to 15 percent of the unit.

Permeability is rapid. Surface runoff is very slow or ponded. Available water capacity is low. Reaction ranges from very strongly acid to medium acid in the subsoil and substratum.

Undrained areas are saturated at or near the surface for long periods. In undrained areas root development is restricted below a depth of about 1 foot. The response to additions of plant nutrients in undrained areas is limited by the excessive wetness, low available water capacity, and acid soil conditions. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content.

Most areas of this soil are woodland and permanent pasture. A few areas are cropland. The potential is fair for cultivated crops, hay, and pasture. It is poor for trees. It is poor for recreational development and engineering uses.

If drained, this soil is suited to crops. The low available water capacity of the soil limits yields. In dry periods drained areas become droughty and yields are severely affected. Legumes are subject to winterkill from ponding and ice sheeting. Tilling and harvesting are difficult in wet periods. Because the sandy material flows easily if wet and sloughs if dry, constructing and maintaining open-ditch drains is difficult. Subsurface tile drains are subject to clogging. Drained areas are subject to soil blowing in dry periods if the soil is left bare and exposed.

Conservation tillage, winter cover crops, and spring plowing can help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility, increases the water-holding capacity of the soil, and reduces soil blowing.

The use of the soil as pastureland or hayland is also effective in controlling soil blowing. Overgrazing, however, results in loss of the plant cover and increases the risk of blowing. Proper stocking, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

This soil is poorly suited to wood crops. Growth is so slow and form so poor that trees are barely merchantable at best. Soil wetness generally requires planting by hand or machine on prepared ridges when natural regeneration is unreliable. Large vigorous nursery stock is essential. The heavy equipment needed in harvesting can be used only when the soil is frozen. Clear-cut or area-selection harvest reduces the risk of windthrow to the rest of the stand. Brushy vegetation competing with natural regeneration can be controlled through the use of suitable herbicides, or it can be removed mechanically.

This soil is poorly suited as a septic tank absorption field and a building site because of the seasonal high water table and the flood hazard. If it is to be used as a building site, it must be drained and protected from flooding. Dwellings should be constructed without basements. If local roads and streets are to function properly, suitable base material should be added.

The capability subclass is IVw. The woodland suitability subclass is 4w.

KwB—Knowles silt loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on hills and upland plateaus where relief is affected by the underlying bedrock. Areas are irregular in shape. They range from about 10 to 80 acres.

Typically, the surface layer of this Knowles soil is dark grayish brown silt loam about 8 inches thick. The subsoil is about 26 inches thick. The upper part is dark brown, friable silt loam. The middle part is dark yellowish brown, friable silty clay loam. The lower part is dark brown, friable clay loam. Limestone bedrock is at a depth of about 34 inches.

Included with this soil in mapping are small areas of McHenry and Ritchie soils in landscape positions similar to those of the Knowles soil. McHenry soils do not have bedrock within a depth of 60 inches. Richey soils are less than 20 inches deep over limestone. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate. Surface runoff is slow or medium. Available water capacity is low or moderate. Reaction ranges from slightly acid to strongly acid in the upper part of the subsoil and from slightly acid to mildly alkaline in the lower part. The shrink-swell potential is moderate.

The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content. Root development is restricted by limestone bedrock below a depth of about 34 inches.

Most areas are farmed. A few small areas are still wooded. The underlying bedrock is a good source of limestone for crushing. There are a few quarries. This soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to good potential for recreational development. It has fair to poor potential for most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. The shallow root zone and the low available water capacity limit yields. Rock outcrop restricts tilling and harvesting in places. If cultivated, the soil is subject to a slight or moderate erosion hazard.

Conservation tillage, winter cover crops, spring plowing, diversions, and grassed waterways help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves tilth and increases water infiltration.

The use of the soil as pastureland or hayland is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is poorly suited as a septic tank absorption field and a site for dwellings with basements because it is shallow over limestone bedrock. There is a possible hazard of polluting nearby water supplies by inadequately treated sewage effluent flowing through crevices in the limestone. Because of the shrinking and swelling of the subsoil, dwellings should have foundations and footings designed to provide the structural support needed. Foundations on the limestone are very stable. Because of the high frost action of the subsoil, local roads and streets are subject to failure. Roads should be graded to shed water if they are to function properly, and suitable base material should be added. Limestone bedrock is a limitation in making cuts and road ditches.

The capability subclass is IIe. The woodland suitability subclass is 2o.

KwC2—Knowles silt loam, 6 to 12 percent slopes, eroded. This sloping, well drained soil is on valley sides in uplands where relief is affected by the underlying bedrock. There is some rock outcrop. Areas are long and narrow. They range from about 5 to 30 acres.

Typically, the surface layer of this Knowles soil is dark grayish brown silt loam about 6 inches thick. The subsoil is about 26 inches thick. The upper part is brown and dark brown, friable silt loam. The middle part is dark yellowish brown, friable silty clay loam. The lower part is dark brown, friable clay loam. Limestone bedrock is at a depth of about 32 inches.

Included with this soil in mapping are small areas of Ritchey soils in landscape positions similar to those of the Knowles soil. They are less than 20 inches deep over limestone. Also included are areas where bedrock is below 40 inches. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate. Surface runoff is medium. Available water capacity is low or moderate. Reaction ranges from slightly acid to strongly acid in the upper part of the subsoil and from slightly acid to mildly alkaline in the lower part. The shrink-swell potential is moderate.

The surface layer tends to crust after heavy rain and is a source of sedimentation. Tillage is restricted in places by rock outcrop. Root development is restricted below a depth of about 32 inches by limestone bedrock.

Most areas are farmed. A few small areas are still wooded. The underlying bedrock is a good source of limestone for crushing. There are a few quarries. This soil has fair potential for cultivated crops, hay, and pasture. It has good potential for growing trees. It has fair to poor potential for engineering uses and fair to good potential for most recreational development.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. The shallow rooting depth and the low available water capacity limit yields. Rock outcrop restricts tilling and harvesting in places. If cultivated, the soil is subject to further erosion.

Conservation tillage, winter cover crops, spring plowing, diversions, and grassed waterways help to prevent excessive soil loss. In a few areas slopes are long enough and smooth enough to be farmed on the contour. Returning crop residue or regularly adding manure improves tilth and increases water infiltration.

The use of the soil as pastureland or hayland is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is poorly suited as a septic tank absorption field and a site for dwellings with basements because it is shallow over limestone bedrock. There is a possible hazard of polluting nearby water supplies by inadequately treated sewage effluent flowing through crevices in the limestone. Because of the shrinking and swelling of the subsoil, dwellings should have foundations and footings designed to provide the structural support needed. The excavation and leveling needed to prepare suitable building sites expose the limestone bedrock. Foundations on the limestone are stable. Because of the high frost action of the subsoil, local roads and streets are subject

to failure. Roads should be graded to shed water if they are to function properly, and suitable base material should be added. Limestone bedrock is a limitation in making cuts and road ditches.

The capability subclass is IIIe. The woodland suitability subclass is 2o.

KyA—Korobago silt loam, 0 to 3 percent slopes. This nearly level to gently sloping, somewhat poorly drained soil is in swales and drainageways. It is subject to occasional flooding or ponding from adjacent uplands. Areas are long and narrow or irregular in shape. They range from about 10 to 200 acres.

Typically, the surface layer of this Korobago soil is black silt loam about 9 inches thick. The subsoil is about 27 inches thick. The upper part is dark yellowish brown, mottled, friable silt loam. The middle part is brown, mottled, very friable loamy very fine sand and friable loam. The lower part is reddish brown, mottled, firm silty clay loam. The substratum to a depth of about 60 inches is reddish brown, mottled, firm silty clay loam. In some areas the surface layer is very fine sandy loam or loam. In places this soil is wetter than is typical.

Included with this soil in mapping are small areas of Manawa and Yahara soils in landscape positions similar to those of the Korobago soil. Manawa soils have more clay in the upper part of the subsoil. Yahara soils lack the finer textured substratum within a depth of 40 inches. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the upper part of the subsoil and moderately slow or slow in the lower part of the subsoil and in the substratum. Surface runoff is slow. Available water capacity is moderate or high. Reaction ranges from slightly acid to mildly alkaline in the subsoil. Free lime occurs in the lower part of the subsoil and in the substratum. The shrink-swell potential is moderate in the lower part of the subsoil and in the substratum.

Undrained areas are saturated for long periods at depths of 1 to 3 feet. The response to additions of plant nutrients in undrained areas is limited by the excessive wetness. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas are farmed. A few small areas are still wooded. The soil has good potential for cultivated crops, hay, and pasture. Undrained areas have fair potential for cropland. The potential is good for trees. It is fair to poor for recreational development and poor for most engineering uses.

If drained, this soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Grasses and legumes are subject to winterkill from ponding and ice sheeting. In undrained areas yields are limited by the excessive wetness. Surface and subsurface drainage is needed. Diversions on nearby uplands can help to prevent ponding.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is suited to construction of the dugout ponds and level ditches that provide open water areas.

This soil is poorly suited as a septic tank absorption field because of wetness, flooding, and slow or moderately slow permeability. It is also poorly suited as a building site. If it is to be used as a building site, it should be drained and protected from flooding. Because of the low strength of the lower subsoil and substratum, dwellings should be constructed without basements, and foundations and footings should be designed to provide the structural support needed. Local roads and streets are subject to failure from high frost action. Roads should be graded to shed water if they are to function properly, and suitable base material should be added.

The capability subclass is IIw. The woodland suitability subclass is 2o.

LmA—Lamartine silt loam, 0 to 3 percent slopes. This nearly level to gently sloping, somewhat poorly drained soil is on valley terraces and in upland drainageways. It is subject to occasional flooding or ponding from adjacent uplands. Areas are long and narrow or irregular in shape. They range from about 10 to 120 acres.

Typically, the surface layer of this Lamartine soil is very dark grayish brown silt loam about 9 inches thick. The subsoil is about 21 inches thick. The upper part is brown, mottled, friable silty clay loam. The lower part is grayish brown, mottled, friable loam. The substratum to a depth of about 60 inches is brown and pale brown, mottled, very friable gravelly fine sandy loam. In some areas the substratum is sand and gravel. In places this soil is wetter than is typical.

Included with this soil in mapping are small areas of well drained LeRoy and Lomira soils, which are in higher landscape positions than those of the Lamartine soil. Included areas make up 5 to 10 percent of the unit.

Permeability is moderate. Surface runoff is slow. Available water capacity is high. Reaction ranges from slightly acid to mildly alkaline in the subsoil. Free lime occurs in the substratum. The shrink-swell potential is moderate in the subsoil.

Undrained areas of this soil are saturated for long periods at depths of 1 to 3 feet. The response to additions of plant nutrients in undrained areas is limited by the excessive wetness. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas of this soil are farmed. A few small areas are still wooded. The potential is good for cultivated crops, hay, pasture, and trees. It is fair to poor for recreational development and poor for most engineering uses.

If drained, this soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Grasses and legumes are subject to winterkill from ponding and ice sheeting. Yields on the undrained

soil are limited by the excessive wetness. Surface and subsurface drainage is needed. Diversions on nearby uplands help to prevent ponding.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is suited to construction of the dugout ponds and level ditches that provide shallow open water areas.

This soil is poorly suited as a septic tank absorption field and a building site because of the seasonal high water table and the flood hazard. If used as a building site, it should be drained and protected from flooding. Dwellings should be constructed without basements. If local roads and streets are to function properly, the subsoil layer should be replaced or covered with suitable base material.

The capability subclass is IIw. The woodland suitability subclass is 2o.

LrB—LeRoy silt loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on the crests and foot slopes of drumlins and upland ridges. Areas are long or irregular in shape. They range from about 5 to 80 acres.

Typically, the surface layer of this LeRoy soil is very dark grayish brown silt loam about 9 inches thick. The subsoil is about 13 inches thick. The upper part is mostly dark brown, friable silty clay loam. The lower part is friable clay loam. The substratum to a depth of about 60 inches is yellowish brown gravelly fine sandy loam. In some areas the subsoil is thinner than is typical. In some eroded areas the surface layer contains more clay than is typical.

Included with this soil in mapping are small areas of the somewhat poorly drained Lamartine soils in shallow depressions and drainageways. In places the surface layer is high in content of gravel. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate. Surface runoff is slow or medium. Available water capacity is moderate. Reaction ranges from medium acid to mildly alkaline in the subsoil. Free lime occurs in the substratum. The shrink-swell potential is moderate in the subsoil.

The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content. Cobblestones and gravel interfere with tillage in some areas. For many crops, root development is restricted below a depth of about 22 inches by the highly calcareous loamy till.

Most areas of this soil are farmed. A few are still wooded. The potential is good for cultivated crops, hay, pasture, and trees. It is fair to good for recreational development and engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Because the soil is droughty during prolonged dry periods, yields are limited in some years. Cobblestones and gravel interfere with tilling and harvesting in some areas. If the soil is used for cultivated crops, it is subject to a slight or moderate erosion hazard.

Conservation tillage, winter cover crops, spring plowing, and grassed waterways help to prevent excessive soil loss and conserve moisture. Returning crop residue or regularly adding manure improves fertility and increases the water-holding capacity of the soil.

The use of the soil as pastureland or hayland is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction and excessive runoff. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is suited as a septic tank absorption field. It is suited as a building site if proper design procedures are used. Because of the shrinking and swelling of the subsoil, buildings should have foundations and footings designed to provide the structural support needed. If local roads and streets are to function properly, the subsoil layer should be replaced or covered with suitable base material.

The capability subclass is IIe. The woodland suitability subclass is 2o.

LrC2—LeRoy silt loam, 6 to 12 percent slopes, eroded. This sloping, well drained soil is on the sides and crests of drumlins, knolls, and ridges. Areas are long and narrow or irregular in shape. Commonly they are 3 to 40 acres.

Typically, the surface layer of this LeRoy soil is very dark grayish brown silt loam about 8 inches thick. The subsoil is about 11 inches thick. The upper part is mostly dark brown, friable silty clay loam. The lower part is friable clay loam. The substratum to a depth of about 60 inches is yellowish brown gravelly fine sandy loam. In some areas the subsoil is very thin or lacking. The surface layer is loam in places. In some eroded areas the surface layer contains more clay than is typical. In some areas slopes are more than 12 percent.

Included with this soil in mapping are areas where the original surface layer and all or part of the subsoil have been lost through erosion. As a result, the surface layer is now gravelly loam or gravelly sandy loam. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate. Surface runoff is medium. Available water capacity is moderate. Reaction ranges from medium acid to mildly alkaline in the subsoil. Free lime occurs in the substratum. The shrink-swell potential is moderate in the subsoil.

The surface layer is erodible and is therefore a source of sedimentation. Cobblestones and gravel interfere with tillage in some areas. For many crops, root development

is restricted below a depth of about 19 inches by the highly calcareous loamy till.

Most areas are farmed. A few are still wooded. The soil has fair potential for cultivated crops, hay, and pasture. It has good potential for growing trees. It has fair to poor potential for recreational development and fair potential for most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Because it becomes droughty during prolonged dry periods, yields are limited in some years. Cobblestones and gravel interfere with tilling and harvesting in some areas. If the soil is used for cultivated crops, it is subject to further erosion.

Long rotations with 1 year of a row crop, conservation tillage, spring plowing, winter cover crops, and grassed waterways help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility and increases the water-holding capacity of the soil.

The use of the soil as pastureland or hayland is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction and excessive runoff. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species competing with natural regeneration can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is suited as a septic tank absorption field and a building site if proper design and installation procedures are used. Filter fields should be on the contour to prevent the effluent from surfacing. Because of the shrinking and swelling of the subsoil, buildings should have foundations and footings designed to provide the structural support needed. Some leveling and land shaping are needed in preparing suitable building sites. If local roads and streets are to function properly, the subsoil layer should be replaced or covered with suitable base material.

The capability subclass is IIIe. The woodland suitability subclass is 2o.

LvB—Lomira silt loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on the lower sides of drumlins, knolls, and ridges. Areas are long or irregular in shape. They range from about 10 to 80 acres.

Typically, the surface layer of this Lomira soil is very dark grayish brown silt loam about 9 inches thick. The subsoil is about 28 inches thick. The upper part is brown and dark yellowish brown, very friable and friable silt loam. The middle part is dark brown, friable silty clay loam. The lower part is dark brown, friable clay loam. The substratum to a depth of about 60 inches is yellowish brown gravelly fine sandy loam. In some areas the solum is thinner than 24 inches or thicker than 40 inches. In places this soil is wetter than is typical.

Included with this soil in mapping are small areas underlain by limestone bedrock within a depth of 60 inches. Included areas make up 5 to 10 percent of the unit.

Permeability is moderate. Surface runoff is slow or medium. Available water capacity is high. Reaction ranges from medium acid to neutral in the upper part of the subsoil and is neutral or mildly alkaline in the lower part. Free lime occurs in the substratum. The shrink-swell potential is moderate in the subsoil.

The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content. For many crops, root development is restricted below a depth of about 37 inches by the highly calcareous loamy till.

Most areas are farmed. A few small areas are still wooded. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to good potential for recreational development and most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated, it is subject to a slight or moderate erosion hazard.

Conservation tillage, winter cover crops, diversions, and grassed waterways help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility and increases water infiltration.

The use of the soil as pastureland or hayland is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction and excessive runoff. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is suited as a septic tank absorption field. It is suited as a building site if proper design procedures are used. Because of the low strength and the shrinking and swelling of the subsoil, buildings should have foundations and footings designed to provide the structural support needed. Local roads and streets are subject to failure from high frost action and the low strength in the subsoil if wet. Roads should be graded to shed water if they are to function properly, and the subsoil layer should be strengthened or replaced with suitable base material.

The capability subclass is IIe. The woodland suitability subclass is 2o.

LzB—Lorenzo Variant loam, 2 to 8 percent slopes. This gently sloping to sloping, moderately well drained soil is on till plains. It occurs at some of the highest positions on the landscape. Slopes are convex. Areas are long and narrow or irregular in shape. They commonly are 5 to 30 acres but range up to about 80 acres.

Typically, the surface layer of this Lorenzo Variant soil is very dark grayish brown loam about 9 inches thick.

The subsoil is about 10 inches thick. The upper part is dark brown, friable clay loam. The lower part is brown, very friable gravelly sandy loam. The substratum to a depth of about 60 inches is brown, mottled very gravelly loamy sand in the upper 11 inches and is reddish brown, mottled, firm clay loam in the lower part. In some areas it is less than 24 inches to the underlying loamy or clayey material. In some areas the surface layer contains more clay than is typical. In places the very gravelly loamy sand is less than 6 inches thick. Some areas have slopes of more than 8 percent. In places this soil is well drained.

Included with this soil in mapping are small areas of the well drained Casco and Hortonville soils, which are in landscape positions similar to those of the Lorenzo Variant. Casco soils do not have loamy or clayey material within a depth of 40 inches. Hortonville soils do not have a gravelly layer above 40 inches. In some areas there is no subsoil. Consequently, the surface layer is commonly gravelly. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the upper part of the subsoil, rapid or very rapid in the gravelly material, and slow or moderately slow in the substratum. Surface runoff is slow or medium. Available water capacity is low. Reaction ranges from slightly acid to moderately alkaline in the subsoil. Free lime occurs in the lower part of the subsoil and in the substratum. The shrink-swell potential is moderate in the upper part of the subsoil and in the lower part of the substratum.

The very gravelly substratum is saturated for long periods after heavy rainfall and during wet seasons. Cobblestones and gravel interfere with tillage in some areas. For many crops, root development is restricted below a depth of about 19 inches by the calcareous very gravelly loamy sand. For most crops, the response to additions of plant nutrients is limited by the low available water capacity. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas of this soil are farmed. A few small areas are still wooded. The potential is fair for cultivated crops, hay, pasture, and trees. It is fair to poor for most recreational development and engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. The low available water capacity limits yields. Some deep rooted plants may get sufficient moisture for good growth. Cobblestones and gravel interfere with tilling and harvesting in some areas. If cultivated, the soil is subject to a slight or moderate erosion hazard.

Conservation tillage, winter cover crops, spring plowing, and grassed waterways help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility and increases the water-holding capacity of the soil.

The use of the soil as pastureland or hayland is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction and excessive runoff. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. Survival of planted trees during dry seasons can be improved by planting vigorous nursery stock. Clear-cut or area-selection harvest reduces the risk of windthrow to the rest of the stand. Brushy species competing with natural regeneration following harvest can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is poorly suited as a septic tank absorption field because of the high seasonal water table and the slow or moderately slow permeability in the underlying loamy or clayey material. Seasonal wetness is a problem in using this soil as a building site. In areas used as sites for dwellings, interception tile should be placed in the gravelly substratum to lower the seasonal water table and prevent seepage from adjoining slopes. The moderate shrinking and swelling and the low strength in the upper part of the subsoil are potential problems in the construction of dwellings without basements and of local roads and streets. These problems can be overcome by removing this layer and replacing it with suitable base material.

The capability subclass is IIIe. The woodland suitability subclass is 3d.

MaA—Manawa silty clay loam, 0 to 3 percent slopes. This nearly level to gently sloping, somewhat poorly drained soil is in drainageways and depressional areas. It is subject to occasional flooding or ponding from adjacent uplands. Areas are long and narrow or irregular in shape. They range from 5 to several hundred acres.

Typically, the surface layer of this Manawa soil is very dark gray silty clay loam about 9 inches thick. The subsoil is about 26 inches thick. The upper part is reddish brown, mottled, firm silty clay loam. The rest of the subsoil and the substratum to a depth of about 60 inches are reddish brown, mottled, firm silty clay. In some places pebbles and stones occur throughout the subsoil and substratum. In some areas the surface layer is loam or silt loam. In places the surface layer is as much as 20 inches thick. In some areas the subsoil and substratum contain less clay than is typical. Some areas of this soil are poorly drained.

Included with this soil in mapping are small areas of Kewaunee and Mosel soils. Kewaunee soils occupy higher landscape positions and are better drained than the Manawa soil. Mosel soils occupy landscape positions similar to those of Manawa soil. In contrast, they have less clay, more sand, and commonly layers of gravel in the subsoil. Also included are areas where the surface layer is loamy fine sand. Included areas make up 5 to 15 percent of the unit.

Permeability is slow. Surface runoff is slow. Available water capacity is moderate. Reaction ranges from slight-

ly acid to moderately alkaline in the subsoil. Free lime occurs in the lower part of the subsoil and in the substratum. The shrink-swell potential is moderate.

Undrained areas are saturated for long periods at depths of 1 to 3 feet. The response to additions of plant nutrients in undrained areas is limited by the excessive wetness. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most of the acreage is farmed. A few areas are still wooded. Many areas have been drained. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to poor potential for recreational development. It has poor potential for most engineering uses.

If drained, this soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Legumes are subject to winterkill from ponding and ice sheeting. Soil compaction and clodding are limitations, especially where the plow layer contains subsoil material.

Timely conservation tillage can help to overcome these limitations. Returning crop residue or regularly adding manure improves tilth and increases water infiltration.

Yields on the undrained soil are limited by the excessive wetness. Surface and subsurface drainage is needed. Diversions on nearby uplands help to prevent ponding.

If the soil is used for pasture, overgrazing should be avoided. Grazing when the soil is wet results in surface compaction and poor tilth. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the soil and the pasture in good condition.

This soil is suitable for wood crops. Seedling survival can be improved by planting vigorous nursery stock. Brushy vegetation competing with natural regeneration following harvest can be controlled through the use of suitable herbicides, or it can be removed mechanically.

The soil is suited to construction of the dugout ponds and level ditches that provide open water areas.

This soil is poorly suited as a septic tank absorption field because of wetness, flooding, and slow permeability. It is also poorly suited as a building site. If used as a building site, it should be drained and protected from flooding. Because of the low strength of the soil, dwellings should be constructed without basements, and foundations and footings should be designed to provide the structural support needed. Local roads and streets are subject to failure from high frost action and the low strength in the soil if wet. Roads should be graded to shed water if they are to function properly, and suitable base material should be added.

The capability subclass is IIw. The woodland suitability subclass is 2c.

MhB—McHenry silt loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on valley sides and on low hills and ridges. Areas are long or irregular in shape. They range from about 10 to 100 acres.

Typically, the surface layer of this McHenry soil is dark grayish brown silt loam about 9 inches thick. The subsoil is about 23 inches thick. The upper part is dark brown and dark yellowish brown, friable silt loam. The lower part is dark brown, friable clay loam. The substratum to a depth of about 60 inches is yellowish brown, very friable fine sandy loam. In some areas this soil is more than 40 inches thick. In some areas the surface layer is darker than described. In places this soil is wetter than is typical.

Included with this soil in mapping are small areas of Fox soils in landscape positions similar to those of the McHenry soil. Fox soils have a sand and gravel substratum. Also included are areas underlain by limestone bedrock within a depth of 60 inches. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate. Surface runoff is slow or medium. Available water capacity is high. Reaction ranges from strongly acid to neutral in the subsoil. Free lime occurs in the substratum. The shrink-swell potential is moderate in the subsoil. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to good potential for recreational development and most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Cultivated areas are subject to a slight or moderate erosion hazard.

Conservation tillage, winter cover crops, diversions, and grassed waterways help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility and increases water infiltration.

The use of the soil as pastureland and hayland is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction and excessive runoff. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is suited as a septic tank absorption field. It is also suited as a building site if proper design procedures are used. Because of the low strength and the shrinking and swelling of the subsoil, buildings should have foundations and footings designed to provide the structural support needed. If local roads and streets are to function properly, the subsoil layer should be replaced or covered with a suitable base material.

The capability subclass is IIe. The woodland suitability subclass is 2o.

MhC2—McHenry silt loam, 6 to 12 percent slopes, eroded. This sloping, well drained soil is on valley sides

and on hills and ridges. Areas are long and narrow. They range from about 5 to 40 acres.

Typically, the surface layer of this McHenry soil is dark grayish brown silt loam about 7 inches thick. The subsoil is about 24 inches thick. The upper part is dark brown and dark yellowish brown, friable silt loam. The lower part is dark brown, friable sandy clay loam. The substratum to a depth of about 60 inches is yellowish brown, very friable fine sandy loam. In some areas this soil is less than 30 inches thick. In some places the surface layer is higher in content of clay than is typical.

Included with this soil in mapping are small areas of Fox soils in landscape positions similar to those of the McHenry soil. Fox soils have a sand and gravel substratum. Also included are areas underlain by limestone bedrock within a depth of 60 inches. In places the surface layer is high in content of gravel. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate. Surface runoff is medium. Available water capacity is high. Reaction ranges from strongly acid to neutral in the subsoil. Free lime occurs in the substratum. The shrink-swell potential is moderate in the subsoil.

The surface layer tends to crust after heavy rain and is a source of sedimentation. Cobblestones and gravel interfere with tillage in some areas.

Most areas are farmed. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to poor potential for most recreational development and most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Cobblestones and gravel interfere with tilling and harvesting in some areas. If the soil is used for cultivated crops, it is subject to further erosion.

Long rotations with only 1 year of a row crop, conservation tillage, spring plowing, winter cover crops, diversions, and grassed waterways help to prevent excessive soil loss. In some areas slopes are long enough and smooth enough to be farmed on the contour. Returning crop residue or regularly adding manure improves fertility and increases water infiltration.

The use of the soil as pastureland or hayland is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction and excessive runoff. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is suited as a septic tank absorption field and a building site if proper design and installation procedures are used. Filter fields should be on the contour to prevent the effluent from surfacing. Because of the low strength and the shrinking and swelling of the subsoil, buildings should have foundations and footings designed to provide the structural support needed. Some leveling and land shaping are needed. If local roads and streets are to function properly, the subsoil layer should be replaced or covered with suitable base material.

The capability subclass is IIIe. The woodland suitability subclass is 3o.

Mn—Menasha clay. This nearly level, poorly drained soil is in lake basins and on stream terraces. It is subject to frequent flooding or ponding. Areas are long and narrow or irregular in shape. They range from about 5 to 100 acres.

Typically, the surface layer of this Menasha soil is black clay about 7 inches thick. The subsoil is about 19 inches thick. The upper part is very dark gray, dark gray, and gray, mottled, firm clay. The lower part is gray and reddish brown, mottled, firm clay. The substratum to a depth of about 60 inches is reddish brown, mottled, firm clay. In some areas this soil contains a few thin strata of sand. In places the surface layer is less than 7 inches thick. In some areas the surface layer is silty clay loam or silty clay. In some areas the substratum contains less clay than is typical and some pebbles and stones.

Included with this soil in mapping are areas underlain by sand or stratified silt and sand within depths of 60 inches. Also included are areas where the surface layer is muck. In some areas the surface layer is mucky loamy fine sand or silt loam. Included areas make up 5 to 15 percent of the unit.

Permeability is slow or very slow. Surface runoff is very slow. Available water capacity is moderate. Reaction ranges from slightly acid to moderately alkaline in the subsoil. Free lime occurs in the substratum. The shrink-swell potential is high.

Undrained areas are saturated within 1 foot of the surface for long periods. Tilth is poor. In undrained areas, root development is restricted below a depth of about 1 foot. The response to additions of plant nutrients in undrained areas is limited by the excessive wetness.

Most areas are farmland and woodland. Many have been drained. The soil has good potential for cultivated crops, hay, pasture, and trees. It has poor potential for recreational development and engineering uses.

If drained, this soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Legumes and grasses are subject to winterkill from ponding and ice sheeting. The soil is difficult to work. It is sticky when wet and hard when dry. Seedbeds are difficult to prepare. The soil must be tilled at the proper moisture content to prevent clodding and soil compaction. Wetness often delays tilling and harvesting.

Timely conservation tillage reduces the risk of soil compaction and clodding. Returning crop residue or regularly adding manure improves tilth and increases water infiltration.

Yields are limited unless the soil is drained. Surface and subsurface drainage is needed. Diversions on

nearby uplands help to prevent ponding. Obtaining suitable drainage outlets is a problem in many areas.

If the soil is used for pasture, overgrazing should be avoided. Grazing when the soil is wet results in surface compaction. Proper stocking, pasture rotation, timely deferment of grazing, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. Because of soil wetness, planting by hand or machine on prepared ridges is needed when natural regeneration is unreliable. Large vigorous nursery stock is essential. The heavy equipment needed in harvesting can be used only when the soil is frozen. Clear-cut or area-selection harvest reduces the risk of windthrow to the rest of the stand. Brushy species competing with natural regeneration can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is suited to construction of the dugout ponds and level ditches that provide open water areas.

This soil is poorly suited as a septic tank absorption field because of wetness, flooding, and slow or very slow permeability. It is poorly suited as a building site. If used as a building site, it must be drained and protected from flooding. Because of the shrinking and swelling of the soil, dwellings should be constructed without basements and foundations and footings should be designed to provide the structural support needed. If local roads and streets are to function properly, a suitable base material should be added.

The capability subclass is IIw. The woodland suitability subclass is 2w.

MoA—Morocco loamy fine sand, 0 to 3 percent slopes. This nearly level to gently sloping, somewhat poorly drained soil is on terraces adjacent to drainageways, basins, and lakes. Areas are long and narrow or irregular in shape. They range from about 5 to 30 acres.

Typically, the surface layer of this Morocco soil is dark brown loamy fine sand about 7 inches thick. The subsoil is about 31 inches thick. The upper part is yellowish brown, very friable fine sand. The lower part of the subsoil and the substratum to a depth of about 60 inches are pale brown, mottled, loose fine sand. In places thin strata of loamy material are in the subsoil or substratum. Available water capacity and the level of natural fertility are slightly higher in these areas. In places this soil is poorly drained. In some areas the surface layer is fine sand.

Included with this soil in mapping are small areas underlain by loamy or clayey materials within a depth of 60 inches. In places, the surface layer and the upper part of the subsoil are fine sandy loam. Included areas make up 5 to 15 percent of the unit.

Permeability is rapid. Surface runoff is very slow. Available water capacity is low. Reaction ranges from medium acid to very strongly acid.

Undrained areas are saturated for long periods at depths of 1 to 3 feet. The response to additions of plant nutrients is limited by the excessive wetness, low available water capacity, and acid soil conditions. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content.

Most areas are woodland and permanent pasture. Some areas are planted to pine trees. The soil has poor potential for cultivated crops, hay, and pasture. It has fair potential for trees. It has fair to poor potential for recreational development and poor potential for most engineering uses.

If drained, this soil is suited to corn and small grain and to grasses and legumes for hay and pasture. The soil is droughty, however, and crop yields are limited by the low available water capacity. Some deep rooted plants may get sufficient moisture for good growth, but a prolonged dry period severely affects yields of all crops. Legumes are subject to winterkill from ponding and ice sheeting. Tilling and harvesting are difficult during wet periods.

Surface and subsurface drainage is needed. Because the sandy material flows easily when wet and sloughs when dry, constructing and maintaining open-ditch drains is difficult. In addition, subsurface drainage tile is subject to clogging. If drained and left bare and exposed, the soil is subject to soil blowing in dry periods.

Conservation tillage, winter cover crops, and spring plowing help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility, increases the water-holding capacity of the soil, and reduces the risk of soil blowing. Frequent liming of this rapidly permeable soil is needed for good crop production.

The use of the soil for pasture or hay is also effective in controlling erosion. Overgrazing, however, results in loss of the plant cover and in soil blowing. Proper stocking, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. Seedling survival can be improved by planting vigorous nursery stock. Brushy vegetation competing with natural regeneration following harvest can be controlled through the use of suitable herbicides, or it can be removed mechanically.

This soil is poorly suited as a septic tank absorption field and a dwelling site because of the seasonal high water table. If used as a building site, it should be drained. Dwellings should be constructed without basements. Because the soil flows when wet and sloughs when dry, sidewalls of excavations are likely to cave in. If local roads and streets are to function properly, a suitable base material should be added.

The capability subclass is IVw. The woodland suitability subclass is 3s.

MtA—Mosel silt loam, 0 to 3 percent slopes. This nearly level to gently sloping, somewhat poorly drained soil is on valley terraces and in drainageways and swales in the uplands. It is subject to occasional flooding or ponding by runoff from the adjacent uplands. Areas

are long and narrow or irregular in shape. They range from about 10 to 100 acres.

Typically, the surface layer is very dark gray silt loam about 9 inches thick. The subsurface layer is dark grayish brown, mottled, friable silt loam about 5 inches thick. The subsoil is about 24 inches thick. The upper part is reddish brown and brown, mottled, friable clay loam, and the lower part is reddish brown, mottled, firm silty clay. The substratum to a depth of about 60 inches is reddish brown, mottled, firm silty clay. In places the substratum contains less clay than is typical. In some areas the surface layer is fine sandy loam or loam. In other areas, it is lighter in color. In places this soil is poorly drained.

Included with this soil in mapping are small areas of Korobago and Manawa soils, which are in landscape positions similar to those of the Mosel soils. Korobago soils have less clay in the upper part of the subsoil. In some areas the subsoil contains a sand and gravel layer that is more than 20 inches thick. In these areas the surface layer commonly is gravelly. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the subsoil and moderately slow or slow in the substratum. Surface runoff is slow. Available water capacity is high. Reaction ranges from neutral to moderately alkaline. Free lime occurs in the lower part of the subsoil and in the substratum. The shrink-swell potential is moderate in the lower part of the subsoil and in the substratum.

Undrained areas are saturated for long periods at depths of 1 to 3 feet. The response to additions of plant nutrients in undrained areas is limited by the excessive wetness. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. Cobblestones and gravel interfere with tillage in some areas.

Most areas are farmed. A few small areas are still wooded. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to poor potential for recreational development and poor potential for most engineering uses.

If drained, this soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Grasses and legumes are subject to winterkill from ponding and ice sheeting. Yields on the undrained soil are limited by the excessive wetness. Surface and subsurface drainage is needed. Diversions on nearby uplands can help to prevent ponding.

In areas where the subsoil is gravelly, the soil is droughty. Yields for most crops in these areas are severely affected during prolonged dry periods. These gravelly areas also interfere with the construction of open-ditch drains and the installation of subsurface drainage tile.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is poorly suited as a septic tank absorption field because of wetness, flooding, and slow or moderately slow permeability. The soil is also poorly suited as a building site. If used as a building site, it should be drained and protected from flooding. Because of the low strength of the soil, dwellings should be constructed without basements, and foundations and footings should be designed to provide the structural support needed. Local roads and streets are subject to failure from high frost action. Roads should be graded to shed water if they are to function properly, and a suitable base material should be added.

The capability subclass is IIw. The woodland suitability subclass is 2o.

Na—Navan silt loam. This nearly level, poorly drained soil is in drainageways and swales in the uplands. It is subject to frequent flooding or ponding. Some areas are long and narrow. Some are long and broad. All range from about 10 to 200 acres.

Typically, the surface layer of this Navan soil is black silt loam about 12 inches thick. The subsoil is about 26 inches thick. The upper part is olive gray, mottled, friable silt loam. The middle part is reddish brown, mottled, friable clay loam. The lower part is reddish brown, mottled, firm clay loam. The substratum to a depth of about 60 inches is reddish brown, mottled, firm silty clay. In some areas the substratum contains less clay than is typical. In some the surface layer is loam or is less than 7 inches thick.

Included with this soil in mapping are small areas of Poygan and Wauseon soils in landscape positions similar to those of the Navan soil. Poygan soils have less gravel and more clay in the upper part of the subsoil. Wauseon soils have less gravel and also less clay in the upper part of the subsoil. In some areas the subsoil contains a layer of sand and gravel. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the upper part of the subsoil and slow or moderately slow in the lower part and in the substratum. Surface runoff is very slow or ponded. Available water capacity is high. Reaction ranges from neutral to moderately alkaline in the subsoil. Free lime occurs in the lower part of the subsoil and in the substratum. The shrink-swell potential is moderate in the substratum.

Undrained areas are saturated within 1 foot of the surface for long periods. In undrained areas root development is restricted below a depth of about 1 foot. The response to additions of plant nutrients is limited unless the soil is drained. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas are farmed. A few small areas are still wooded. The soil has good potential for cultivated crops, hay, and pasture and fair potential for trees. It has poor potential for recreational development and engineering uses.

If drained, this soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Grasses and legumes are subject to winterkill from ponding and ice sheeting. In undrained areas yields are limited by the excessive wetness. Surface and subsurface drainage is needed. Obtaining suitable drainage outlets is a problem in many areas. Diversions on nearby uplands help to prevent ponding.

This soil is suitable for wood crops. Planting by hand or machine on prepared ridges is generally needed when natural regeneration is unreliable. Large vigorous nursery stock is essential. The heavy equipment needed in harvesting can be used only when the soil is frozen. Clearcut or area-selection harvest reduces the risk of windthrow to the rest of the stand. Brushy vegetation competing with natural regeneration can be controlled through the use of suitable herbicides, or it can be removed mechanically.

This soil is suited to construction of the dugout ponds and level ditches that provide open water areas.

This soil is poorly suited as a septic tank absorption field because of wetness and slow or moderately slow permeability. It is poorly suited as a building site. If used as a building site, it must be drained and protected from flooding. Because of the low strength of the soil, dwellings should be constructed without basements and foundations and footings should be designed to provide the structural support needed. If local roads and streets are to function properly, suitable base material should be added.

The capability subclass is IIw. The woodland suitability subclass is 4w.

NeA—Nebago fine sand, 0 to 3 percent slopes. This nearly level to gently sloping, somewhat poorly drained soil is mostly in broad glacial lake basins in slightly elevated sand knolls and ridges. It is also in drainageways in the till uplands. Areas are long and narrow or irregular in shape. They range from about 5 to 100 acres.

Typically, the surface layer of this Nebago soil is very dark brown fine sand about 9 inches thick. The subsoil is about 37 inches thick. The upper 25 inches is mostly dark yellowish brown and grayish brown, mottled, very friable and loose fine sand. The lower part is mostly reddish brown, mottled, firm clay. The substratum to a depth of about 60 inches is reddish brown, mottled, firm clay. In some areas the underlying clay contains thin strata of sand. In some areas the clay is underlain by sand within a depth of 60 inches. In some areas this soil contains less clay in the subsoil and substratum than is typical. In some the upper sandy deposits are less than 20 inches thick or the surface layer is loamy fine sand. In places this soil is poorly drained.

Included with this soil in mapping are small areas of Brems and Morocco soils, which are sandy throughout. Included areas make up 5 to 15 percent of the unit.

Permeability is rapid in the upper sandy deposits and slow or moderately slow in the underlying loamy or clayey material. Surface runoff is very slow or ponded. Available water capacity is low. Reaction ranges from medium acid to neutral in the upper sandy deposits and from slightly acid to mildly alkaline in the loamy or clayey material. Free lime occurs in the substratum. The shrink-swell potential is high in the lower part of the subsoil and in the substratum.

Undrained areas are saturated for long periods at depths of 1 to 3 feet. The response to additions of plant nutrients in undrained areas is limited by the excessive wetness and the low available water capacity of the upper sandy deposits. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content.

Most areas are farmed. A few small areas are still wooded. The soil has fair potential for cultivated crops, hay, pasture, and trees. It has poor potential for recreational development and most engineering uses.

This soil is suited to corn and small grain and to grasses and legumes for hay and pasture. Yields are limited by the excessive wetness and the low available water capacity. Legumes are subject to winterkill from ponding and ice sheeting. Surface and subsurface drainage is needed. Because the sandy material flows when wet and sloughs when dry, constructing and maintaining open-ditch drains is difficult. In addition, subsurface drainage tile in the sandy deposits is subject to clogging.

In drained areas the upper part of the soil is droughty, and yields for most crops are severely affected during prolonged dry periods. Some deep rooted plants may get sufficient moisture for good growth. Drained soil is also subject to soil blowing during dry periods if it is left bare and exposed.

Conservation tillage, winter cover crops, and spring plowing help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility, increases the water-holding capacity of the soil, and reduces the risk of soil blowing.

The use of the soil as pastureland or hayland is also effective in controlling erosion. Overgrazing, however, results in loss of the plant cover and in soil blowing. Proper stocking, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species competing with natural regeneration can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is poorly suited as a septic tank absorption field because of the seasonal high water table and the slow permeability in the lower part of the subsoil and in the substratum. It is also poorly suited as a building site. If used as a building site, it should be drained. Because of the low strength and the shrinking and swelling in the lower part of the soil, dwellings should be constructed without basements and foundations and footings should

be designed to provide the structural support needed. To overcome the hazard of frost action, roads should be graded to shed water and suitable base material should be added.

The capability subclass is IIIw. The woodland suitability subclass is 2s.

Ng—Nebago Variant mucky loamy fine sand. This nearly level, very poorly drained soil is in depressional areas of glacial lake basins. It is subject to frequent flooding. Areas are long and narrow or irregular in shape. They range from about 5 to 40 acres.

Typically, the surface layer of this Nebago Variant is black mucky loamy fine sand about 7 inches thick. The subsoil is about 36 inches thick. The upper 18 inches is dark gray, dark grayish brown, and brown, mottled, very friable and loose fine sand. The lower part is reddish gray and reddish brown, mottled, firm clay. The substratum to a depth of about 60 inches is brown, mottled sand. In some areas the sandy substratum is below a depth of 60 inches. In some the lower part of the subsoil and the substratum contain less clay than is typical. In places the upper sandy deposits are less than 20 inches thick. The surface layer is muck or mucky fine sand in places.

Included with this soil in mapping are small areas of Kingsville soils, which are sandy throughout. Some areas are underlain by stratified silt and sand. Included areas make up 5 to 15 percent of the unit.

Permeability is rapid in the upper sandy deposits and slow in the underlying loamy or clayey material. Surface runoff is very slow or ponded. Available water capacity is low. Reaction ranges from slightly acid to strongly acid in the upper sandy deposits and from slightly acid to mildly alkaline in the clay. The shrink-swell potential is high in the clayey material.

Undrained areas are saturated at or near the surface for long periods. In undrained areas root development is restricted below a depth of about 1 foot. The response to additions of plant nutrients is limited by the excessive wetness in undrained areas and by the low available water capacity in drained areas. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content.

Most of the acreage is farmland and woodland or in wetland vegetation, such as marsh grasses, sedges, reeds, and cattails. If drained, the soil has fair potential for cultivated crops, hay, and pasture. Unless drained, it has poor potential for crops and trees. It has poor potential for recreational development and engineering uses.

If drained, this soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. For most crops, yields are limited by the low available water capacity in the sandy material. Some deep rooted crops may get sufficient moisture for good growth. Legumes are subject to winterkill from ponding and ice sheeting. In undrained areas yields are limited by the excessive wetness. Because the sandy material flows easily if wet and sloughs if dry, constructing and maintaining open-ditch drains is difficult. Subsurface drainage tile in the sandy material is subject to clogging. Drained areas are subject to soil blowing in dry periods if the soil is left bare and exposed.

Conservation tillage, winter cover crops, and spring plowing prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility, increases the water-holding capacity of the soil, and reduces soil blowing.

The use of the soil as pasture or hayland is also effective in controlling soil blowing. Overgrazing, however, results in loss of the plant cover and increases the risk of blowing. Proper stocking, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

This soil is poorly suited to wood crops. Growth is so slow and form so poor that trees are barely merchantable at best. Soil wetness generally requires planting by hand or machine on prepared ridges when natural regeneration is unreliable. Large vigorous nursery stock is essential. The heavy equipment needed in harvesting can be used only when the soil is frozen. Clear-cut or area-selection harvest reduces the risk of windthrow to the rest of the stand. Brushy vegetation competing with natural regeneration can be controlled through the use of suitable herbicides, or it can be removed mechanically.

This soil is suited to construction of the dugout ponds and level ditches that provide shallow open water areas. Because the sandy deposits flow if wet, sidewalls of excavations are likely to cave in.

This soil is poorly suited as a septic tank absorption field and a building site because of the seasonal high water table and the flood hazard. If used as a building site, it must be drained and protected from flooding. Because of the shrinking and swelling in the lower part of the subsoil, dwellings should be constructed without basements and foundations and footings should be designed to provide the structural support needed. If local roads and streets are to function properly, suitable base material should be added.

The capability subclass is IIIw. The woodland suitability subclass is 4w.

NhA—Neenah silty clay loam, 0 to 3 percent slopes. This nearly level to gently sloping, somewhat poorly drained soil is in glacial lake basins and on terraces. It is subject to occasional flooding or ponding from adjacent higher areas. Areas are long and broad or irregular in shape. They range from about 10 to several hundred acres.

Typically, the surface layer of this Neenah soil is dark brown silty clay loam about 7 inches thick. The subsoil is dark reddish brown and reddish brown, mottled firm clay about 22 inches thick. The substratum to a depth of about 60 inches is reddish brown, mottled, firm clay. In some areas the substratum contains a few thin strata of sand. In places the subsoil and substratum contain less

clay than is typical. In some areas the surface layer is silt loam or silty clay. In places this soil is poorly drained.

Included with this soil in mapping are small areas underlain by sand or stratified loamy deposits within a depth of 60 inches. In some areas the surface layer is clay or loamy fine sand. Included areas make up 2 to 10 percent of the unit.

Permeability is slow or very slow. Surface runoff is slow. Available water capacity is moderate. Reaction ranges from slightly acid to moderately alkaline in the subsoil. Free lime occurs in the lower part of the subsoil and in the substratum. The shrink-swell potential is high.

Undrained areas are saturated for long periods at depths of 1 to 3 feet. The response to additions of plant nutrients in undrained areas is limited by the excessive wetness. Tilth is poor.

Most areas of this soil are farmed. A few areas are still wooded. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to poor potential for recreational development and poor potential for most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Legumes are subject to winterkill from ponding and ice sheeting. The soil is difficult to work. It is sticky when wet and hard when dry. Seedbeds are difficult to prepare. The soil must be tilled at the proper moisture content to prevent clodding and soil compaction. Wetness often delays tilling and harvesting. Yields are limited in undrained areas.

Surface and subsurface drainage is needed. Diversions on nearby uplands help to prevent ponding. Timely conservation tillage reduces the risk of soil compaction and clodding. Returning crop residue or regularly adding manure improves tilth and increases water infiltration.

If the soil is used for pasture, overgrazing should be avoided. Grazing when the soil is wet results in surface compaction. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. Seedling survival can be improved by careful planting of vigorous nursery stock. Brushy vegetation competing with natural regeneration following harvest can be controlled through the use of suitable herbicides, or it can be removed mechanically.

The soil is suited to construction of the dugout ponds and ditches that provide open water areas.

This soil is poorly suited as a septic tank absorption field because of wetness, flooding, and slow or very slow permeability. It is also poorly suited as a building site. If used as a building site, it should be drained and protected from flooding. Because of the shrinking and swelling of the soil, dwellings should be constructed without basements, and foundations and footings should be designed to provide the structural support needed. Local roads and streets should be graded to shed water if they are to function properly, and a suitable base material should be added.

The capability subclass is IIw. The woodland suitability subclass is 2c.

NnA—Nenno loam, 0 to 3 percent slopes. This nearly level to gently sloping, somewhat poorly drained soil is in drainageways and on foot slopes of drumlins. It is subject to occasional flooding or ponding from runoff of the adjacent uplands. Areas are long and narrow or irregular in shape. They range from about 10 to 200 acres.

Typically, the surface layer of this Nenno soil is very dark gray loam about 9 inches thick underlain by very dark grayish brown, mottled loam about 2 inches thick. The subsoil is dark brown and brown, mottled, friable loam about 10 inches thick. The substratum to a depth of about 60 inches is brown, mottled, friable gravelly fine sandy loam. In some areas the surface layer is silt loam. In some areas the subsoil is fine sandy loam. In places this soil is poorly drained.

Included with this soil in mapping are small areas of Mosel soils in landscape positions similar to those of the Nenno soil. Mosel soils have loamy or clayey glacial till at a depth of 20 to 40 inches. Some areas are underlain by limestone within a depth of 60 inches. In places, the surface layer has a high content of gravel. Included areas make up 10 to 15 percent of the unit.

Permeability is moderate. Surface runoff is slow. Available water capacity is moderate. Reaction is neutral or mildly alkaline in the subsoil. Free lime occurs in the lower part of the subsoil and in the substratum. The shrink-swell potential is moderate in the subsoil.

Undrained areas are saturated for long periods at depths of 1 to 3 feet. The response to additions of plant nutrients in undrained areas is limited by the excessive wetness. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content. Cobblestones and gravel interfere with tillage in some areas.

Most areas of this soil are farmed. A few small areas are still wooded. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to poor potential for recreational development and poor potential for engineering uses.

If drained, this soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Legumes are subject to winterkill from ponding and ice sheeting. The gravelly substratum hinders construction of open-ditch drains and installation of subsurface tile. Yields on the undrained soil are limited by the excessive wetness.

Surface and subsurface drainage is needed. Diversions on nearby uplands help to prevent ponding.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is poorly suited as a septic tank absorption field and a building site because of the seasonal high

water table and the hazard of flooding. If used as a building site, it should be drained and protected from flooding. Dwellings should be constructed without basements. If local roads and streets are to function properly, the subsoil layer should be replaced or covered with suitable base material.

The capability subclass is IIw. The woodland suitability subclass is 2o.

OaB—Oakville fine sand, 2 to 6 percent slopes. This gently sloping, well drained soil is on terraces, low ridges, and hills. Areas are long and narrow or irregular in shape. They range from about 10 to several hundred acres.

Typically, the surface layer of this Oakville soil is very dark brown fine sand about 4 inches thick. The subsoil is brown and yellowish brown, very friable fine sand about 20 inches thick. The substratum to a depth of about 60 inches is light yellowish brown fine sand. In places this soil is wetter than is typical.

Included with this soil in mapping are small areas of Tustin soils, which have loamy or clayey material within a depth of 40 inches. These areas make up 2 to 10 percent of the unit.

Permeability is rapid. Surface runoff is very slow. Available water capacity is low. Reaction ranges from medium acid to very strongly acid in the subsoil and substratum. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content. The response to additions of plant nutrients is limited by the low available water capacity and the acid soil conditions.

Most areas of this soil are woodland and farmland. A few areas have been planted to pines (fig. 2). This soil is a good source of sand, and there are some pits. The soil has poor potential for cultivated crops, hay, pasture, and trees. It has good potential for irrigated crops if nutrients are added. It has poor potential for recreational development and good or poor potential for engineering uses.

This soil is suited to crops and pasture, but crop yields are limited by the low available water capacity. Cultivated areas are subject to severe soil blowing during dry periods if the soil is left bare and exposed.

Figure 2.—Red pine on sandy Oakville soil grows well and controls soil blowing.

Conservation tillage, winter cover crops, and spring plowing help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility, increases the water-holding capacity of the soil, and reduces the risk of soil blowing.

The use of the soil as pasture or hayland is also effective in controlling soil blowing. Overgrazing, however, results in loss of the plant cover and increases the risk of blowing. Proper stocking, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

This soil is poorly suited to wood crops. Growth is slow, and trees tend to be poorly formed. Poor seedling survival in dry years can be offset to a degree by planting vigorous nursery stock. Planting trees to control active blowouts and dune movement may be advisable.

This soil is suited as a septic tank absorption field and a building site. There is a possible hazard of polluting nearby water supplies, however, by sewage effluent flowing through the soil too rapidly for purification. Because the soil is subject to sloughing, sidewalls of excavations are likely to cave in.

The capability subclass is IVs. The woodland suitability subclass is 4s.

OaC—Oakville fine sand, 6 to 12 percent slopes. This sloping, well drained soil is on side slopes of terraces and ridges. Some areas are long and narrow. Some are oval. All range from about 5 to 80 acres.

Typically, the surface layer of this Oakville soil is very dark gray fine sand about 3 inches thick over 1 inch of dark grayish brown fine sand. The subsoil is yellowish brown, very friable fine sand about 18 inches thick. The substratum to a depth of about 60 inches is light yellowish brown fine sand. In some areas, slopes are more than 12 percent.

Included with this soil in mapping are small areas underlain by clayey or loamy deposits within a depth of 60 inches. These areas make up 2 to 10 percent of the unit.

Permeability is rapid. Surface runoff is slow. Available water capacity is low. Reaction ranges from medium acid to very strongly acid in the subsoil and substratum. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content. The response to additions of plant nutrients is limited by the low available water capacity and the acid soil condition.

Most areas of this soil are woodland. A few areas have been planted to pines. Some areas are cropland or pasture. The soil is a good source of sand, and there are some sand pits. The soil has poor potential for cultivated crops, hay, pasture, and trees. It has poor potential for recreational development and fair to poor potential for engineering uses.

This soil is generally not suited to crops because it is droughty. Cultivated areas are subject to severe soil blowing during dry periods if the soil is left bare and exposed.

Conservation tillage, winter cover crops, and spring plowing help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility, increases the water-holding capacity of the soil, and reduces the risk of soil blowing.

The use of the soil as pasture or hayland is also effective in controlling soil blowing, but yields are low. Overgrazing results in loss of the plant cover and increases the risk of blowing. Proper stocking, pasture rotation, and timely deferment of grazing help to keep the soil and the pasture in good condition.

This soil is poorly suited to wood crops. Growth is slow, and trees tend to be poorly formed. Poor seedling survival in dry years can be offset to a degree by planting vigorous nursery stock. Planting trees to control active blowouts and dune movement may be advisable.

This soil is suited as a septic tank absorption field and a building site if proper design and installation procedures are used. Filter fields should be laid out on the contour to prevent the effluent from surfacing. There is a possible hazard of polluting nearby water supplies by sewage effluent flowing through the soil too rapidly for purification. Some leveling and land shaping are needed in preparing suitable building sites. Because the soil is subject to sloughing, sidewalls of excavations are likely to cave in.

The capability subclass is VIs. The woodland suitability subclass is 4s.

OmB—Omro clay loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on crests and sides of broad hills. Areas are long and broad or irregular in shape. They range from about 10 to 300 acres.

Typically, the surface layer of this Omro soil is dark brown clay loam about 8 inches thick. The subsoil is about 28 inches thick. The upper part is reddish brown, firm clay. The lower part is reddish brown, firm silty clay. The substratum to a depth of about 60 inches is yellowish brown, very friable gravelly fine sandy loam. In some areas the subsoil is thinner than is typical. The surface layer is loam or silt loam or in places silty clay loam.

Included with this soil in mapping are small areas of Kewaunee soils in landscape positions similar to those of the Omro soil. Kewaunee soils have more clay and less sand and gravel in the substratum. Also included are areas underlain by limestone bedrock within a depth of 60 inches. Included areas make up 5 to 15 percent of the unit.

Permeability is slow or moderately slow in the subsoil and moderate in the substratum. Surface runoff is slow or medium. Water ponds in swales and in low areas after excessive rainfall. Available water capacity is moderate. Reaction ranges from medium acid to neutral in the upper part of the subsoil and from slightly acid to mildly alkaline in the lower part. Free lime occurs in the lower part of the subsoil and in the substratum. The shrink-swell potential is moderate in the subsoil. The surface layer is friable and can be easily tilled throughout a fairly

wide range in moisture content. It tends to crust or puddle after hard rain, especially in eroded areas where the plow layer contains subsoil material.

Most areas of this soil are farmed. A few areas are still wooded. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to good potential for recreational development and fair to poor potential for most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. In eroded areas, soil compaction and poor tilth are limitations. Deferment of tilling and harvesting is needed during wet periods. Cultivated areas are subject to a slight or moderate erosion hazard.

Conservation tillage, winter cover crops, spring plowing, diversions, and grassed waterways help to prevent excessive soil loss. Returning crop residue or regularly adding manure reduces crusting, improves tilth, and increases water infiltration.

The use of the soil as pasture or hayland is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. Seedling survival can be improved by planting vigorous nursery stock. Brushy vegetation competing with natural regeneration following harvest can be controlled through the use of suitable herbicides, or it can be removed mechanically.

This soil is poorly suited as a septic tank absorption field because of the moderately slow permeability in the subsoil. Installing the filter field in the more permeable substratum increases the absorption rate. This soil is also poorly suited as a building site. Because of the low strength in the subsoil, buildings should have foundations and footings designed to provide the structural support needed. If local roads and streets are to function properly, the subsoil layer should be replaced or covered with suitable base material.

The capability subclass is IIe. The woodland suitability subclass is 2c.

Os—Ossian silt loam. This nearly level, poorly drained soil is in depressional areas and in upland drainageways. It is subject to frequent flooding or ponding. Areas are long and narrow or irregular in shape. They range from about 10 to 200 acres.

Typically, the surface layer of this Ossian soil is black silt loam about 12 inches thick. The subsoil is olive gray, mottled, friable silt loam about 18 inches thick. The substratum to a depth of about 60 inches is olive gray, mottled, friable silt loam. In some areas the substratum contains thin strata of sand. In some, the surface layer is muck.

Included with this soil in mapping are small areas underlain by fine sandy loam glacial till or by sand and gravel within a depth of 60 inches. These areas make up 5 to 15 percent of the unit.

Permeability is moderate. Surface runoff is very slow or ponded. Available water capacity is high. Reaction is neutral or mildly alkaline in the subsoil and substratum. The shrink-swell potential is moderate.

Undrained areas are saturated within 1 foot of the surface for long periods. In undrained areas, root development is restricted below a depth of about 1 foot. The response to additions of plant nutrients in undrained areas is limited by the excessive wetness. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas of this soil are farmed. A few small areas are still wooded. The soil has good potential for cultivated crops, hay, and pasture and fair potential for trees. It has poor potential for recreational development and engineering uses.

If drained, this soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay or pasture. Grasses and legumes are subject to winterkill from ponding and ice sheeting. Yields on the undrained soil are limited by the excessive wetness.

Surface and subsurface drainage is needed. Obtaining suitable drainage outlets is a problem in many areas. Diversions on nearby uplands can help to prevent ponding.

This soil is suitable for wood crops. Because the soil is wet, planting by hand or machine on prepared ridges is needed when natural regeneration is unreliable. Large vigorous nursery stock is essential. The heavy equipment needed in harvesting can be used only when the soil is frozen. Clear-cut or area-selection harvest helps to reduce the risk of windthrow to the rest of the stand. Brushy vegetation competing with natural regeneration can be controlled through the use of suitable herbicides, or it can be removed mechanically.

This soil is suited to construction of the dugout ponds and level ditches that provide open water areas.

This soil is poorly suited as a septic tank absorption field and a building site because of the seasonal high water table and the flood hazard. If used as a building site, it should be drained and protected from flooding. Dwellings should be constructed without basements. If local roads and streets are to function properly, suitable base material should be added.

The capability subclass is IIw. The woodland suitability subclass is 3w.

Pa—Palms muck. This nearly level, very poorly drained soil is in depressional and low areas adjacent to drainageways and old lake basins. It is subject to frequent flooding. Areas are long and narrow or irregular in shape. They commonly are 80 to 200 acres but range from about 10 to 300 acres.

Typically, the upper 3 inches of this Palms soil is very dark brown muck. The next 22 inches is black muck. The substratum to a depth of about 60 inches is grayish brown, friable silt loam that contains a few thin strata of sand. In some areas the substratum contains thick layers

of sand. In places the organic deposits are less than 16 inches thick.

Included with this soil in mapping are small areas of Adrian, Houghton, and Willette soils, which formed in organic material. These soils occupy landscape positions similar to those of the Palms soil. Adrian soils are underlain by sand, and Willette soils by clay. Houghton soils are organic to a depth of 51 inches or more. Some areas of these soils adjacent to streams and lakes are covered with 1 to 3 feet of water most of the year. Included areas make up 5 to 10 percent of the unit.

Permeability is moderately rapid in the organic material and moderate or moderately slow in the substratum. Surface runoff is very slow or ponded. Available water capacity is very high. Reaction ranges from medium acid to mildly alkaline in the organic material.

Unless drained, the soil is saturated at or near the surface most of the year. In undrained areas, root development is restricted. The response to additions of plant nutrients in undrained areas is limited by the excessive wetness. The surface layer is very friable and can be easily tilled.

Most of the acreage is in wetland vegetation such as marsh grass, sedges, reeds, redosier brush, and cattails. A few areas are drained and are used for crops and grass sod. The soil has good potential for sod, some specialty crops, and some cultivated crops. It has fair potential for trees. It has poor potential for recreational development and engineering uses.

This soil must be drained for dependable crop production. If drained, it is suited to corn and soybeans but is generally not suited to small grain and to grasses and legumes for hay. The flood hazard and a short growing season, caused by frost late in spring and early in fall, limit yields and restrict the types of crops that can be grown. Soil blowing and subsidence are hazards if the soil is drained and cultivated. Winter cover crops, controlled drainage, and restricted use when the soil is wet help to minimize these hazards. Obtaining suitable drainage outlets is a problem in many areas. Undrained areas are limited to marsh hay production during dry years. Pasture is restricted to dry periods.

This soil is suitable for wood crops. Soil wetness and a high water table during the tree planting season limit reforestation to natural regeneration. The heavy equipment needed in harvesting can be used only when the soil is frozen. Clear-cut or area-selection harvest is needed to avoid a serious hazard of windthrow to the rest of the stand. Brushy species competing with natural regeneration can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is suited to construction of the dugout ponds and level ditches that provide shallow open water areas for waterfowl and muskrat production. The wetland vegetation provides suitable habitat for many wildlife species.

This soil is poorly suited as a septic tank absorption field and a building site because of the seasonal high water table and the frequent flooding.

The capability subclass is IIw. The woodland suitability subclass is 3w.

Pg—Pits, gravel. These are excavation pits from which sand and gravel, or in a few places glacial till, have been removed. They are irregular in shape and range from 3 to 80 acres.

The material in the bottom and sidewalls of these pits ranges from sand and gravel to clay. Some of the abandoned pits are filled with water.

Included with this unit in mapping are areas of spoil, which is soil material pushed from the pit area before excavation, and piles of material that did not contain enough gravel or for some reason was discarded. Also included are stones or boulders too large to crush.

Soil material associated with pits is typically sandy or loamy and is droughty. Other soil properties are highly variable.

Reclaiming the areas of pits is the main management concern. Land shaping and addition of suitable topsoil are needed in most areas if they are to support a plant cover.

Pits are not assigned to a capability subclass or woodland suitability subclass.

Ph—Pits, quarries. These are excavation pits from which limestone has been removed. They are rectangular areas that range from 3 to 40 acres.

The bottom and sidewalls of quarries are fractured limestone. Water ponds in the lower parts of some pits for a considerable period.

Included with this unit in mapping are areas of spoil, which is soil material pushed from the quarry area before excavation, and piles of broken limestone.

Soil material associated with quarries is typically loamy and is droughty. Other soil properties are highly variable.

Reclaiming the quarried areas is the main management concern. Land shaping and addition of suitable topsoil are needed in most areas if they are to support a plant cover.

Pits are not assigned to a capability subclass or a woodland suitability subclass.

PsB—Plano silt loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on broad upland till plains. Areas are irregular in shape. They range from about 10 to several hundred acres.

Typically, the surface layer of this Plano soil is about 15 inches thick. The upper 12 inches is black silt loam. The next 3 inches is very dark grayish brown silt loam. The subsoil is about 40 inches thick. The upper part is brown and dark brown, friable silt loam and silty clay loam. The lower part is dark brown, friable sandy loam. The substratum to a depth of about 60 inches is brown, very friable sandy loam. In places the surface layer is less than 10 inches thick. In some areas it is lighter colored than is typical. The upper layers are fine sandy loam in some areas. In places this soil is wetter than is typical.

Included with this soil in mapping are areas underlain by limestone bedrock within a depth of 60 inches. These areas make up 5 to 15 percent of the unit.

Permeability is moderate. Surface runoff is slow or medium. Water ponds in swales and low areas for short periods after excessive rainfall. Available water capacity is high. Reaction ranges from medium acid to neutral in the subsoil. Free lime occurs in the substratum. The shrink-swell potential is moderate in the subsoil. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas of this soil are farmed. The soil has good potential for cultivated crops, hay, and pasture. It has fair to good potential for recreational development. It has fair to poor potential for most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. If cultivated, it is subject to a slight or moderate erosion hazard.

Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility and increases water infiltration.

The use of the soil as pasture or hayland is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction and excessive runoff. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suited as a septic tank absorption field and a building site. Because of the low strength and the shrinking and swelling in the subsoil, dwellings should have foundations and footings designed to provide the structural support needed. Local roads and streets should be graded to shed water if they are to function properly, and suitable base material should be added.

The capability subclass is IIe. The soil is not assigned to a woodland suitability subclass.

Pt—Poy silty clay loam. This nearly level, poorly drained soil is in slightly depressed areas in old lake basins and on stream terraces. It is subject to frequent flooding or ponding. Areas are long and narrow or irregular in shape. They range from about 5 to 300 acres.

Typically, the surface layer of this Poy soil is black silty clay loam about 9 inches thick. The subsoil is about 25 inches thick. The upper part is very dark gray and grayish brown, mottled, firm clay. The lower part is reddish brown, mottled, firm clay. The substratum to a depth of about 60 inches is brown fine and medium sand. In some areas the substratum contains layers of finer textured material. In some areas the surface layer is silty clay or silt loam. In places the depth to sand is less than 20 inches or more than 40 inches.

Included with this soil in mapping are small areas of Menasha soils in landscape positions similar to those of the Poy soil. Menasha soils do not have sand within a depth of 40 inches. Also included are areas where the surface layer is clay, mucky loamy fine sand, or muck. Included areas make up 5 to 10 percent of the unit.

Permeability is slow or very slow in the subsoil and rapid in the substratum. Surface runoff is very slow or ponded. Available water capacity is low or moderate. Reaction in the subsoil ranges from slightly acid to moderately alkaline. The shrink-swell potential is high in the subsoil.

Undrained areas are saturated within 1 foot of the surface for long periods. In undrained areas, root development is restricted below a depth of about 1 foot. The response to additions of plant nutrients in undrained areas is limited by the excessive wetness. Tilth is poor.

Most areas of this soil are farmland and woodland. Many areas have been drained. The soil has fair potential for cultivated crops, hay, and pasture and good potential for trees. It has poor potential for recreational development and engineering uses.

If drained, this soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Legumes are subject to winterkill from ponding and ice sheeting. The soil is difficult to work. It is sticky when wet and hard when dry. Seedbeds are difficult to prepare. Yields are limited by excessive wetness. Surface and subsurface drainage is needed. Obtaining suitable drainage outlets is a problem in some areas. Subsurface drainage tile placed in the sandy substratum is subject to clogging. This soil must be tilled at the proper moisture content to prevent clodding and soil compaction. Wetness often delays tilling and harvesting.

Timely use of conservation tillage helps to reduce soil compaction and clodding. Returning crop residue or the regular addition of manure improves tilth and increases water infiltration.

If the soil is used as pasture, overgrazing should be avoided. Grazing when the soil is wet results in surface compaction. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. Because the soil is wet, planting by hand or machine on prepared ridges is needed when natural regeneration is unreliable. Large vigorous nursery stock is essential. The heavy equipment needed in harvesting can be used only when the soil is frozen. Clear-cut or area-selection harvest reduces the risk of windthrow to the rest of the stand. Brushy vegetation competing with natural regeneration can be controlled through the use of suitable herbicides, or it can be removed mechanically.

This soil is suited to construction of the dugout ponds and level ditches that provide shallow open water areas. Because the substratum flows if wet, sidewalls of excavations are likely to cave in.

This soil is poorly suited as a septic tank absorption field because of wetness, flooding, and slow or very slow permeability. It is poorly suited as a building site. If used as a building site, it must be drained and protected from flooding. Because of the shrinking and swelling of the

subsoil, dwellings should be constructed without basements, and foundations and footings should be designed to provide the structural support needed. Because the substratum flows if wet, sidewalls of excavations are likely to cave in. If local roads and streets are to function properly, suitable base material should be added.

The capability subclass is IIw. The woodland suitability subclass is 2w.

Pu—Poygan silty clay loam. This nearly level, poorly drained soil is in drainageways and depressional areas. It is subject to frequent flooding or ponding. Areas are long and narrow or irregular in shape. They range from about 5 to 200 acres.

Typically, the surface layer of this Poygan soil is black silty clay loam about 9 inches thick. The subsoil is about 24 inches thick. The upper part is mostly dark gray and olive gray, mottled, firm silty clay. The lower part is reddish brown, mottled, firm silty clay. The substratum to a depth of about 60 inches is reddish brown, mottled, firm silty clay. There are some pebbles and stones throughout the subsoil and substratum. In some areas the surface layer is loam or silt loam. In places it is as much as 30 inches thick. In places this soil is saturated at depths greater than is typical.

Included with this soil in mapping are small areas of Navan and Wauseon soils in landscape positions similar to those of the Poygan soil. Navan and Wauseon soils have more sand and less clay in the subsoil. Also included are areas where the surface layer is mucky loamy fine sand. Included areas make up 5 to 15 percent of the unit.

Permeability is slow. Surface runoff is very slow or ponded. Available water capacity is moderate. Reaction ranges from slightly acid to moderately alkaline in the subsoil. Free lime occurs in the lower part of the subsoil and in the substratum. The shrink-swell potential is moderate.

Undrained areas are saturated within 1 foot of the surface for long periods. In undrained areas root development is restricted below a depth of about 1 foot. The response to additions of plant nutrients in undrained areas is limited by the excessive wetness. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas of this soil are farmed. Many have been drained. The soil has good potential for cultivated crops, hay, pasture, and trees. It has poor potential for recreational development and engineering uses.

If drained, this soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Grasses and legumes are subject to winterkill from ponding and ice sheeting. Soil compaction and clodding are limitations, especially where the plow layer contains subsoil material. In undrained areas yields are limited by the excessive wetness.

Timely conservation tillage can help overcome limitations. Returning crop residue or regularly adding manure improves tilth and increases water infiltration. Surface and subsurface drainage is needed. Obtaining suitable drainage outlets is a problem in many areas.

If the soil is used as pasture, overgrazing should be avoided. Grazing when the soil is wet results in surface compaction and poor tilth. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. Because the soil is wet, planting by hand or machine on prepared ridges is generally needed when natural regeneration is unreliable. Large vigorous nursery stock is essential. The heavy equipment needed in harvesting can be used only when the soil is frozen. Clear-cut or area-selection harvest reduces the risk of windthrow to the rest of the stand. Brushy species competing with natural regeneration can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is suited to construction of the dugout ponds and level ditches that provide open water areas.

This soil is poorly suited as a septic tank absorption field because of wetness, flooding, and slow permeability. It is poorly suited as a building site. If it is to be used as a building site, it must be drained and protected from flooding. Because of the low strength of the soil, dwellings should be constructed without basements, and foundations and footings should be designed to provide the structural support needed. If local roads and streets are to function properly, suitable base material should be added.

The capability subclass is IIw. The woodland suitability subclass is 2w.

PzB—Puchyan loamy fine sand, 2 to 6 percent slopes. This gently sloping, moderately well drained soil is on valley terraces and convex hills. Areas are irregular in shape. They range from about 10 to 150 acres.

Typically, the surface layer of this Puchyan soil is dark brown loamy fine sand about 9 inches thick. The subsurface layer is yellowish brown, very friable fine sand about 12 inches thick. The subsoil is about 36 inches thick. The upper part is brown, mottled, friable fine sandy loam. The middle part is yellowish brown, mottled, friable loam. The lower part is light olive brown and dark yellowish brown, mottled, friable silt loam. The substratum to a depth of about 60 inches is olive brown, mottled, friable silt loam. In places the surface layer is fine sand. In some areas the upper sandy deposits are less than 20 inches thick. In places the substratum is fine sandy loam. In some areas this soil is well drained.

Included with this soil in mapping are small areas where the upper sandy deposits are more than 40 inches thick and areas where the substratum is sand and gravel. Included areas make up 2 to 10 percent of the unit.

Permeability is moderately rapid or rapid in the upper sandy material and moderate in the loamy layers. Surface runoff is slow. Available water capacity is moderate.

Reaction ranges from medium acid to neutral in the subsoil.

This soil is saturated for long periods at depths of 3 to 6 feet. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content. The soil is highly erodible, especially in the more sloping areas. It is an important source of sedimentation. The response to additions of plant nutrients is limited for most crops by the droughty upper sandy material.

Most areas of this soil are farmed. The soil has fair potential for cultivated crops, hay, pasture, and trees. It has fair potential for recreational development. It has fair to poor potential for most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Because the upper sandy material is droughty, yields for most crops are limited. Yields are severely affected in prolonged dry periods. Cultivated areas are subject to soil blowing in dry periods if the soil is left bare and exposed.

Conservation tillage, winter cover crops, and spring plowing help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility, increases the water-holding capacity of the soil, and reduces the risk of soil blowing.

The use of the soil as pasture or hayland is also effective in controlling soil blowing. Overgrazing, however, results in loss of the plant cover and increases the risk of blowing. Proper stocking, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is poorly suited as a septic tank absorption field because of the seasonal high water table. Because of the low strength in the lower part of the subsoil and in the substratum, buildings should have foundations and footings designed to provide the structural support needed. If this soil is to be used as a site for dwellings with basements, it should be drained. Local roads and streets should be graded to shed water if they are to function properly, and suitable base material should be added.

The capability subclass is IIIe. The woodland suitability subclass is 3o.

RhB—Ritchey silt loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on upland plateaus where relief is affected by the underlying bedrock. Rock outcrop is common. Areas are irregular in shape and range from about 5 to 40 acres.

Typically, the surface layer of this Ritchey soil is dark grayish brown silt loam about 8 inches thick. The subsoil is about 9 inches thick. It is mostly dark brown, friable clay loam and sandy clay loam. Limestone bedrock is at a depth of about 17 inches. In some areas the subsoil is redder and has a higher content of clay than is typical. In some areas the soil is less than 10 inches thick over limestone. The surface layer is loam, clay loam, or silty clay loam in places.

Included with this soil in mapping are areas underlain by limestone bedrock at a depth of more than 20 inches. These areas make up 2 to 10 percent of the unit.

Permeability is moderate. Surface runoff is slow or medium. Available water capacity is low. Reaction ranges from slightly acid to mildly alkaline in the subsoil. The shrink-swell potential is moderate.

The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content. Rock outcrop restricts tillage in places. Root development is restricted below a depth of about 17 inches by limestone bedrock. The response to additions of plant nutrients is limited by the shallow rooting depth and the low available water capacity.

Many areas of this soil are farmed. A few are still wooded. Some are pasture. The underlying bedrock is a good source of limestone for crushing. There are a few quarries. This soil has fair potential for cultivated crops, hay, pasture, and trees. It has fair to poor potential for most recreational development and poor potential for engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Yields are limited by the shallow rooting depth and the low available water capacity. The rock outcrop and the shallowness over rock restrict tilling and harvesting in some areas. If cultivated, the soil is subject to a slight or moderate erosion hazard. Soil compaction and poor tilth are limitations in eroded areas.

Timely deferment of tilling and harvesting is needed during wet periods. Conservation tillage, winter cover crops, and spring plowing help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves tilth and increases the water-holding capacity of the soil.

The use of the soil as pasture or hayland is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. Survival of planted trees during dry seasons can be improved by planting vigorous nursery stock. Clear-cut or area-selection harvest reduces the risk of windthrow to the rest of the stand. Brushy vegetation competing with natural regeneration following harvest can be controlled through the use of suitable herbicides, or it can be removed mechanically.

This soil is poorly suited as a septic tank absorption field and a building site because it is shallow over limestone. There is a possible hazard of polluting nearby water supplies by inadequately treated sewage effluent

flowing through crevices in the limestone. Foundations constructed on the limestone are very stable. The bedrock is a limitation in making cuts and road ditches.

The capability subclass is IIIe. The woodland suitability subclass is 3d.

RhC2—Ritchey silt loam, 6 to 12 percent slopes, eroded. This sloping, well drained soil is on valley sides in the uplands where relief is affected by the underlying bedrock (fig. 3). Rock outcrop is common. Areas are long and narrow and range from about 5 to 30 acres.

Typically, the surface layer of this Ritchey soil is dark grayish brown silt loam about 6 inches thick. The subsoil is dark brown, friable clay loam about 10 inches thick. Limestone bedrock is at a depth of about 16 inches. In some areas the subsoil is redder and has a higher clay content than is typical. In places the surface layer has a higher clay content than is typical, or it is loam. In some areas the soil is less than 10 inches deep over limestone.

Included with this soil in mapping are small areas where the depth to limestone is more than 20 inches. These areas make up 2 to 10 percent of the unit.

Permeability is moderate. Surface runoff is medium. Available water capacity is low. Reaction ranges from slightly acid to mildly alkaline in the subsoil. The shrink-swell potential is moderate.

The surface layer tends to crust after heavy rain and is a source of sedimentation to lower areas. Rock outcrop and the shallowness over rock make tillage impractical in many areas. Roots are restricted below a depth of about 16 inches. The response to additions of plant nutrients is limited by the shallow root zone and the low available water capacity.

Most areas of this soil are farmland, pasture, and woodland. The underlying bedrock is a good source of limestone for crushing. This soil has poor potential for cultivated crops and fair potential for hay, pasture, and trees. It has fair to poor potential for most recreational development. It has poor potential for engineering uses.

This soil is suited to grasses and legumes for hay and pasture but is generally not suited to cultivated crops. Rock outcrop and the shallowness over rock restrict tilling and harvesting in many areas. Crop yields are limited by the shallow root zone and the low available water capacity. Soil compaction and poor tilth are limita-

Figure 3.—Sloping Ritchey soil on bedrock controlled ridges. Rock outcrop commonly limits the use of this soil to pasture or woodland.

tions in eroded areas. Cultivated areas are subject to further erosion.

Timely deferment of tilling and harvesting is needed during wet periods. Conservation tillage, winter cover crops, and spring plowing help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves tilth, increases the water-holding capacity of the soil, and reduces crusting.

The use of the soil as pasture or hayland is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suited to wood crops. Survival of planted trees during dry seasons can be improved by planting vigorous nursery stock. Clear-cut or area-selection harvest reduces the risk of windthrow to the rest of the stand. Brushy vegetation competing with natural regeneration following harvest can be controlled through the use of suitable herbicides, or it can be removed mechanically.

This soil is poorly suited as a septic tank absorption field and a building site because it is shallow over limestone bedrock. There is a possible hazard of polluting nearby water supplies by inadequately treated sewage effluent flowing through crevices in the limestone. Foundations on the limestone are very stable. The bedrock is a limitation in making cuts and road ditches.

The capability subclass is IVe. The woodland suitability subclass is 3d.

RhD2—Ritchey silt loam, 12 to 30 percent slopes, eroded. This moderately steep to steep, well drained soil is on valley sides and ridges of uplands where relief is affected by the underlying bedrock. Rock outcrop is common. Areas are long and narrow and range from 5 to 30 acres.

Typically, the surface layer of this Ritchey soil is dark grayish brown silt loam about 5 inches thick. The subsoil is dark brown, friable clay loam about 9 inches thick. Limestone bedrock is at a depth of about 14 inches. In some areas the subsoil is redder and has a higher clay content than is typical. In places the surface layer has a higher clay content than is typical, or it is loam. In some areas limestone is within a depth of 10 inches. In some areas slopes are more than 30 percent.

Included with this soil in mapping are small areas where the depth to limestone is more than 20 inches. These areas make up 2 to 10 percent of the unit.

Permeability is moderate. Surface runoff is rapid. Available water capacity is low. Reaction ranges from slightly acid to mildly alkaline. The shrink-swell potential is moderate.

The surface layer tends to crust after heavy rain and is a source of sedimentation to lower areas. Rock outcrop and the shallowness over rock make tillage impractical in many areas. Roots are restricted below a depth of about 14 inches. The response to additions of plant nutrients is limited by the shallow root zone and the low available water capacity.

Most areas of this soil are farmland, pasture, and woodland. This soil is a good source of limestone for crushing. It has poor potential for cultivated crops and fair potential for hay, pasture, and trees. It has fair to poor potential for recreational development and poor potential for engineering uses.

This soil is generally not suited to cultivated crops because of the steepness of slope. It is best suited to grasses and legumes for hay and pasture. Yields are limited by the shallow root zone and the low available water capacity. The erosion hazard is severe in cultivated areas. The soil should be tilled only when needed for reseeding. Rock outcrop and the shallowness over rock restrict tilling and harvesting in many areas and are hazards to machinery. In tilling for reseeding grasses and legumes, timely conservation tillage is needed to prevent excessive soil loss. Seed should be planted early enough to establish good ground cover before the end of the growing season.

If this soil is used for pasture, overgrazing should be avoided. Grazing when the soil is wet causes surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. Planting trees on the contour and selecting the best location for skid roads during harvest help in erosion control and improve trafficability of equipment. Mortality of planted trees can be reduced by care in planting and by selecting vigorous nursery stock. Clear-cut or area-selection harvest reduces the risk of windthrow to the rest of the stand. Brushy species competing with natural regeneration following harvest can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is poorly suited as a septic tank absorption field and a building site because of the shallowness over limestone and the steepness of slope. Excavation of the limestone needed in preparing suitable building sites is difficult and expensive. Development should be restricted to the less sloping areas.

The capability subclass is VIe. The woodland suitability subclass is 3d.

ScB—St. Charles silt loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on the lower upland hillsides and on high valley terraces. Areas are long or irregular in shape. They range from about 10 to 300 acres.

Typically, the surface layer of this St. Charles soil is dark grayish brown silt loam about 9 inches thick. The subsurface layer is brown silt loam about 3 inches thick. The subsoil is about 44 inches thick. The upper part is mostly dark yellowish brown, friable silt loam and silty

clay loam. The lower part is dark brown, friable sandy clay loam and very friable sandy loam. The substratum to a depth of about 60 inches is brown fine sandy loam. In places this soil is saturated within a depth of 5 feet.

Included with this soil in mapping are small areas where the substratum is sand and gravel or is reddish clayey deposits. Also included are areas where limestone bedrock is within a depth of 60 inches. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate. Surface runoff is slow or medium. Water ponds in swales and in low areas for short periods after excessive rainfall. Available water capacity is high. Reaction ranges from slightly acid to strongly acid in the upper silty material in the subsoil and is slightly acid or neutral in the lower part. The shrink-swell potential is moderate in the subsoil. Free lime occurs in the substratum. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas of this soil are farmed. A few small areas are still wooded. The soil has good potential for recreational development. It has fair to poor potential for most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. The erosion hazard is slight in cultivated areas.

Conservation tillage, winter cover crops, and grassed waterways help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility and increases water infiltration.

The use of the soil as pasture or hayland is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, causes surface compaction and excessive runoff. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species competing with natural regeneration can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is suited as a septic tank absorption field. Dwellings should have foundations and footings designed to provide the structural support needed. Local roads and streets should be graded to shed water if they are to function properly, and the subsoil should be strengthened or replaced with suitable base material.

The capability subclass is IIe. The woodland suitability subclass is 2o.

TuB—Tustin fine sand, 2 to 6 percent slopes. This gently sloping, well drained soil is on convex hills and lower side slopes. Areas are irregular in shape. They range from about 5 to 80 acres.

Typically, the surface layer of this Tustin soil is dark brown fine sand about 8 inches thick. The subsoil is about 38 inches thick. The upper 18 inches is dark yellowish brown, very friable fine sand. The middle part is dark brown, friable sandy clay loam. The lower part is reddish brown, firm clay. The substratum to a depth of about 60 inches is reddish brown, firm clay loam. In some places the surface layer is loamy fine sand. In places the upper sandy deposits are less than 18 inches or more than 40 inches thick.

Included with this soil in mapping are small areas of Nebago soils, which are seasonally saturated at depths of about 1 to 3 feet. In places in the northern part of the county, the lower part of the subsoil is loam or clay loam that is underlain by sand and gravel outwash at depths of 40 to 60 inches. Included areas make up 5 to 15 percent of the unit.

Permeability is rapid in the upper sandy deposits and slow in the substratum. Surface runoff is very slow. Available water capacity is moderate. Reaction ranges from strongly acid to neutral in the upper sandy deposits and from medium acid to mildly alkaline in the lower part. The shrink-swell potential is moderate in the lower part of the subsoil and in the substratum. Free lime occurs in the substratum. For most crops the response to additions of plant nutrients is limited by the low available water capacity in the upper sandy deposits. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content.

Most areas of this soil are farmed. A few small areas are still wooded. The soil has fair potential for cultivated crops, hay, pasture, and trees. It has poor potential for recreational development. It has fair to poor potential for engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Because the upper sandy deposits are droughty, yields for most crops are low. Yields are severely affected in prolonged dry periods. Cultivated areas are subject to soil blowing in dry periods if the soil is left bare and exposed.

Conservation tillage, winter cover crops, and spring plowing help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility, increases the water-holding capacity of the soil, and reduces soil blowing.

The use of the soil as pasture or hayland is also effective in controlling erosion. Overgrazing, however, results in loss of the plant cover and in soil blowing. Proper stocking, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species competing with natural regeneration can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is poorly suited as a septic tank absorption field because of slow permeability in the lower part of the subsoil and in the substratum. It is also poorly suited as a building site. Because of low strength in the lower

part of the subsoil and in the substratum, buildings should have foundations and footings designed to provide the structural support needed.

The capability subclass is IIIe. The woodland suitability subclass is 3o.

UoA—Udorthents, 0 to 3 percent slopes. These nearly level to gently sloping, moderately well drained to somewhat poorly drained soils are adjacent to major drainageways and lakes. They are also in low areas within or adjacent to urban centers. They are subject to occasional flooding or ponding. Areas are long and narrow or irregular in shape. They range from about 5 to several hundred acres.

These Udorthents consist of 1 to 4 feet of fill material over poorly drained and very poorly drained soils. The fill material commonly is clay, silty clay, silty clay loam, and clay loam. It contains some pebbles and stones. The buried soil is mineral or organic, including soils, such as Menasha, Kingsville, and Houghton. Much of the fill material is deposited in former areas of the ponded Houghton soils. In places, these soils are wetter than described.

Included with these soils in mapping are small areas of Neenah soils that are not covered with fill material; areas where the fill material is sand or is mostly nonsoil material, such as concrete, cinders, or trash; small areas of spoilbank deposits adjacent to ditches and canals; and some small manmade islands of rock piles or soil material. Included areas make up 5 to 15 percent of the unit.

Permeability is moderately slow or slow. Surface runoff is slow. Available water capacity is moderate. The shrink-swell potential is moderate. These soils are saturated for long periods at depths of 1 to 5 feet and commonly at a depth of 1 to 3 feet.

Most areas of these soils are used for homesites, lawns, home gardens, and shrubs and trees. Many areas are paved with concrete, asphalt, or gravel.

These soils are generally poorly suited as a septic tank absorption field because of the seasonal high water table and the moderately slow or slow permeability. Sanitary facilities should be connected to commercial sewers and treatment facilities if they are available. These soils are poorly suited as a building site because of wetness. Dwellings should be constructed without basements. Because of the low strength and the shrinking and swelling of the soil, foundations and footings should be designed to provide the structural support needed. These soils lack sufficient strength and stability to support vehicular traffic. The base material should be strengthened or replaced.

Udorthents are not assigned to a capability subclass or a woodland suitability subclass.

We—Wauseon silt loam. This nearly level, poorly drained soil is in drainageways and swales in the uplands. It is subject to frequent flooding. Areas are long and narrow or irregular in shape. They range from about 5 to 80 acres.

Typically, the surface layer of this Wauseon soil is black silt loam about 13 inches thick. The subsoil is about 22 inches thick. The upper part is olive gray and grayish brown, mottled, very friable silt loam. The middle part is olive gray, mottled, very friable fine sandy loam. The lower part is light olive gray, mottled, very friable very fine sandy loam. The substratum to a depth of about 60 inches is reddish brown, mottled, firm silty clay loam. In places the surface layer is very fine sandy loam or loam. In places the subsoil is less than 20 inches thick.

Included with this soil in mapping are small areas of Keowns soils, which do not have the finer textured material within a depth of 40 inches. Also included are areas where the subsoil dominantly is fine sand or loamy fine sand and in some areas has a thin layer of gravel. Included areas make up 5 to 15 percent of the unit.

Permeability is moderate in the subsoil and slow or moderately slow in the substratum. Surface runoff is very slow or ponded. Available water capacity is moderate or high. Reaction is neutral or mildly alkaline in the subsoil. The shrink-swell potential is moderate in the substratum. Free lime occurs in the lower part of the subsoil and in the substratum.

Undrained areas are saturated within 1 foot of the surface for long periods. In undrained areas root development is restricted below a depth of about 1 foot. The response to additions of plant nutrients in undrained areas is limited by the excessive wetness. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas of this soil are cropland, pasture, and woodland. The soil has good potential for cultivated crops, hay, and pasture. It has fair potential for trees. It has poor potential for recreational development and engineering uses.

If drained, this soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Grasses and legumes are subject to winterkill from ponding and ice sheeting. Yields on the undrained soil are limited by the excessive wetness. Surface and subsurface drainage is needed. Obtaining suitable drainage outlets is a problem in many areas. Subsurface drainage tile is subject to clogging.

This soil is suitable for wood crops. Because the soil is wet, planting by hand or by machine on prepared ridges is generally needed when natural regeneration is unreliable. Large vigorous nursery stock is essential. The heavy equipment needed in harvesting can be used only when the soil is frozen. Clear-cut or area-selection harvest reduces the risk of windthrow to the rest of the stand. Brushy vegetation competing with natural regeneration can be controlled through the use of suitable herbicides, or it can be removed mechanically.

This soil is poorly suited as a septic tank absorption field because of wetness, flooding, and slow or moderately slow permeability. It is poorly suited as a building site. If it is to be used as a building site, it should be

drained and protected from flooding. Because of the low strength in the substratum, dwellings should be constructed without basements, and foundations and footings should be designed to provide the structural support needed. If local roads and streets are to function properly, suitable base material should be added.

The capability subclass is IIIw. The woodland suitability subclass is 3w.

WfB—Whalan loamy fine sand, 2 to 8 percent slopes. This gently sloping to sloping, well drained soil is on hills and upland plateaus where relief is affected by the underlying bedrock. Areas are long and narrow or irregular in shape. They range from about 10 to 40 acres.

Typically, the surface layer of this Whalan soil is dark brown loamy fine sand about 7 inches thick. The subsoil is about 25 inches thick. The upper 7 inches is brown, very friable loamy fine sand. The middle part is brown, friable sandy clay loam. The lower part is reddish brown, firm clay loam. Limestone bedrock is at a depth of about 32 inches. In some areas the subsoil is clay or silty clay. In places the sandy surface deposits are more than 20 inches. In some areas slopes are greater than 8 percent.

Included with this soil in mapping are small areas of Hortonville soils in landscape positions similar to those of the Whalan soil. Hortonville soils do not have limestone within a depth of 60 inches. These areas make up 5 to 15 percent of the unit.

Permeability is moderate. Surface runoff is slow. Available water capacity is low or moderate. Reaction ranges from medium acid to mildly alkaline in the subsoil. The shrink-swell potential is moderate. Roots are restricted below a depth of about 32 inches by the limestone bedrock. For some crops the response to additions of plant nutrients is limited by the low available water capacity in the sandy surface deposits. The surface layer is very friable and can be easily tilled throughout a wide range in moisture content.

Most areas of this soil are farmed. A few are still wooded. The underlying bedrock is a good source of limestone for crushing. This soil has fair potential for cultivated crops, hay, and pasture. It has good potential for trees. It has fair potential for recreational development and fair to poor potential for most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Yields are limited by the low available water capacity of the sandy deposits and the shallow root zone. Cultivated areas are subject to soil blowing in dry periods if the soil is left bare and exposed.

Conservation tillage, winter cover crops, and spring plowing help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves fertility, increases the water-holding capacity of the surface layer, and reduces soil blowing.

The use of the soil as pasture or hayland is also effective in controlling erosion. Overgrazing, however, will result in loss of the plant cover and in soil blowing. Proper stocking, pasture rotation, and timely deferment of grazing help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species competing with natural regeneration can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is poorly suited as a septic tank absorption field and a site for dwellings with basements because of the shallowness over limestone bedrock. There is a possible hazard of polluting nearby water supplies by inadequately treated sewage effluent flowing through crevices in the limestone. Because of the low strength and the shrinking and swelling in the subsoil, dwellings should have foundations and footings designed to provide the structural support needed. Foundations on the limestone are stable. If local roads and streets are to function properly, suitable base material should be added. The bedrock is a limitation in making cuts and road ditches.

The capability subclass is IIe. The woodland suitability subclass is 2o.

WhB—Whalan silt loam, 2 to 6 percent slopes. This gently sloping, well drained soil is on hills and upland plateaus where relief is affected by the underlying bedrock. Areas are irregular in shape. They range from about 5 to 120 acres.

Typically, the surface layer of this Whalan soil is dark grayish brown silt loam about 9 inches thick. The subsoil is about 26 inches thick. The upper part is dark brown, friable clay loam. The lower part is reddish brown, firm clay loam. Limestone bedrock is at a depth of about 35 inches. Some areas have a thin layer of gravelly fine sandy loam till between the subsoil and the underlying limestone. In places the surface layer has a higher clay content than is typical, or it is loam. In places the subsoil has a higher clay content than is typical.

Included with this soil in mapping are small areas of Hortonville, Kewaunee, and Ritchey soils in landscape positions similar to those of the Whalan soil. Hortonville and Kewaunee soils do not have limestone within a depth of 60 inches. Ritchey soils have limestone within a depth of 20 inches. These areas make up 5 to 15 percent of the unit.

Permeability is moderate. Surface runoff is slow or medium. Water ponds in swales and in low areas for short periods after excessive rainfall. Available water capacity is low or moderate. Reaction ranges from medium acid to mildly alkaline in the subsoil. The shrink-swell potential is moderate. Tillage is restricted in places by the rock outcrop. Roots are restricted below a depth of about 35 inches. The surface layer is friable and can be easily tilled throughout a fairly wide range in moisture content, but it tends to crust after rainfall and dry into

hard clods, especially in eroded areas where the plowed layer contains subsoil material.

Most areas of this soil are farmed. A few small areas are still wooded. The underlying bedrock is a good source of limestone for crushing. There are a few quarries. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to good potential for recreational development and fair to poor potential for most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Yields are limited by the shallow root zone and the low available water capacity. Rock outcrop restricts tilling and harvesting in places. Soil compaction and poor tilth are limitations in eroded areas. Deferment of tilling and harvesting is needed during wet periods. The erosion hazard is slight to moderate in cultivated areas.

Conservation tillage, winter cover crops, spring plowing, diversions, and grassed waterways help to prevent excessive soil loss. Returning crop residue or regularly adding manure improves tilth, reduces crusting, and increases water infiltration.

The use of the soil as pasture or hayland is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species competing with natural regeneration can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is poorly suited as a septic tank absorption field and a site for dwellings with basements because it is shallow over limestone bedrock. There is a possible hazard of polluting nearby water supplies by inadequately treated sewage effluent flowing through crevices in the limestone. Because of the low strength and the shrinking and swelling of the subsoil, dwellings should have foundations and footings designed to provide the structural support needed. Foundations on the limestone are very stable. If local roads and streets are to function properly, suitable base material should be added. The bedrock is a limitation in making cuts and road ditches.

The capability subclass is IIe. The woodland suitability subclass is 2o.

WhC2—Whalan silt loam, 6 to 12 percent slopes, eroded. This sloping, well drained soil is on valley sides in uplands where relief is affected by the underlying bedrock. Rock outcrop is common. Areas are long and narrow or broad. They commonly are about 3 to 30 acres.

Typically, the surface layer of this Whalan soil is dark grayish brown silt loam about 7 inches thick. The subsoil is about 22 inches thick. The upper part is dark brown, friable silty clay loam. The lower part is reddish brown, firm clay loam. Limestone bedrock is at a depth of about 29 inches. In places the surface layer has a higher clay content than is typical, or it is loam. In places the subsoil has a higher clay content than is typical.

Included with this soil in mapping are small areas of Hortonville, Kewaunee, and Ritchey soils in landscape positions similar to those of the Whalan soil. Hortonville and Kewaunee soils do not have limestone within a depth of 60 inches. Ritchey soils have limestone within a depth of 20 inches. These areas make up 5 to 15 percent of the unit.

Permeability is moderate. Surface runoff is medium. Available water capacity is low or moderate. Reaction ranges from medium acid to mildly alkaline in the subsoil. The shrink-swell potential is moderate. The surface layer tends to crust after heavy rain and is a source of sedimentation to lower areas. Tilth is poor in eroded areas. Tillage is restricted in places by the rock outcrop. Roots are restricted below a depth of about 29 inches by the limestone bedrock.

Most areas of this soil are farmland and woodland. The underlying bedrock is a good source of limestone for crushing. There are a few quarries. This soil has fair potential for cultivated crops, hay, and pasture and good potential for trees. It has fair to good potential for most recreational development and fair to poor potential for engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Yields are limited by the shallow root zone and the low available water capacity. Rock outcrop restricts tilling and harvesting in places. Soil compaction and poor tilth are limitations in eroded areas. Timely deferment of tilling and harvesting is needed. Soil used for cultivated crops is subject to further erosion.

Conservation tillage, winter cover crops, spring plowing, and grassed waterways help to prevent excessive soil loss. In a few areas slopes are long enough and smooth enough to be farmed on the contour. Returning crop residue or regularly adding manure improves tilth, reduces crusting, and increases water infiltration.

The use of the soil as pasture or hayland is also effective in controlling erosion. Overgrazing or grazing when the soil is wet, however, results in surface compaction, excessive runoff, and poor tilth. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species competing with natural regeneration can be controlled through the use of suitable herbicides, or they can be removed mechanically.

This soil is poorly suited as a septic tank absorption field and a site for dwellings with basements because it is shallow over limestone. There is a possible hazard of polluting nearby water supplies by inadequately treated

sewage effluent flowing through crevices in the limestone. Because of the low strength and the shrinking and swelling in the subsoil, dwellings should have foundations and footings designed to provide the structural support needed. The excavation and leveling of the soil needed in preparing suitable building sites exposes the limestone bedrock. Foundations on the limestone are very stable. If local roads and streets are to function properly, suitable base material should be added. The bedrock is a limitation in making cuts and road ditches.

The capability subclass is IIIe. The woodland suitability subclass is 2o.

Wm—Willette muck. This nearly level, very poorly drained soil is in old lake basins and in low areas adjacent to drainageways and lakes. It is subject to frequent flooding. Areas are long and narrow or irregular in shape. They range from about 10 to over 1,500 acres.

Typically, the organic material in this Willette soil is black muck about 26 inches thick. The substratum to a depth of about 60 inches is very dark gray and gray silty clay over reddish brown, firm clay. In some areas the clay substratum contains thin strata of sandy or loamy materials. In places the organic material is less than 16 inches thick.

Included with this soil in mapping are small areas of Adrian, Houghton, and Palms soils in landscape positions similar to those of the Willette soil. Houghton soils are organic to a depth of more than 51 inches. Adrian soils are underlain by sandy material. Palms soils are underlain by loamy material. Some areas of these soils adjacent to streams and lakes are covered with 1 to 3 feet of water most of the year. Included areas make up 5 to 15 percent of the unit.

Permeability is moderately rapid in the organic material and slow in the substratum. Surface runoff is very slow or ponded. Available water capacity is very high. Reaction ranges from medium acid to mildly alkaline in the organic material.

Unless drained, this soil is saturated at or near the surface most of the year. In undrained areas, root development is restricted. The response to additions of plant nutrients in undrained areas is limited by the excessive wetness. If dry, the surface layer is very friable and can be easily tilled.

Most of the acreage is woodland or is in wetland vegetation, such as marsh grasses, sedges, reeds, redosier brush, and cattails. A few areas are drained and are used for crops and grass sod. The soil has good potential for sod, some specialty crops, and some cultivated crops. It has fair potential for trees. It has poor potential for recreational development and engineering uses.

This soil must be drained for dependable crop production. If drained, it is suited to corn and soybeans. Generally it is not suited to small grain and to grasses and legumes for hay. The flood hazard and a short growing season, caused by frost late in spring and early in fall, limit yields and restrict the types of crops that can be grown. Soil blowing and subsidence are hazards if the soil is drained and cultivated. Winter cover crops, controlled drainage, and restricted use when the soil is wet can help to minimize these hazards. Obtaining suitable drainage outlets is a problem in many areas. Undrained areas are limited to marsh hay production during dry years. The use of this soil as pasture is restricted to dry periods.

This soil is suitable for wood crops. Soil wetness and a high water table during the tree planting season limit reforestation to natural regeneration. The heavy equipment needed in harvesting can be used only when the soil is frozen. Clear-cut or area-selection harvest is needed to avoid a serious hazard of windthrow to the rest of the stand. Brushy species competing with natural regeneration can be controlled through the use of suitable herbicides or they can be removed mechanically.

This soil is suited to construction of the dugout ponds and level ditches that provide shallow open water areas for waterfowl and muskrat production. The wetland vegetation provides suitable habitat for many wildlife species.

This soil is poorly suited as a septic tank absorption field and building site because of the seasonal high water table and the frequent flooding.

The capability subclass is IIIw. The woodland suitability subclass is 3w.

WnB—Winneconne silty clay loam, 1 to 4 percent slopes. This nearly level to gently sloping, moderately well drained soil is in lake basins and on broad stream terraces. Areas are long and broad or irregular in shape. They commonly are 40 to 80 acres but range from about 10 to several hundred acres.

Typically, the surface layer of this Winneconne soil is very dark brown silty clay loam about 7 inches thick. The subsoil is reddish brown, firm clay about 15 inches thick. The lower part is mottled. The substratum to a depth of about 60 inches is reddish brown, mottled, firm clay. In some areas the substratum contains thin strata of sand. In some areas adjacent to till uplands, the subsoil is underlain by glacial till containing some pebbles and stones and less clay than is typical. In places this soil is wetter than is typical. In some areas the surface layer is silt loam or silty clay.

Included with this soil in mapping are small areas underlain by sand or stratified silt and sand within depths of 60 inches. In some areas the surface layer is loamy fine sand or clay. Included areas make up 2 to 10 percent of the unit.

Permeability is slow or very slow. Surface runoff is slow or medium. Water ponds in swales and in low areas after excessive rainfall. Available water capacity is moderate. Reaction commonly is neutral or mildly alkaline in the subsoil. In places the upper part of the soil is medium acid or slightly acid. The shrink-swell potential is high. Free lime occurs in the lower part of the subsoil and in the substratum.

This soil is saturated for long periods at depths of 3 to 5 feet. Tilth is poor. For many crops roots are restricted

by the platy structure in the substratum below a depth of about 22 inches.

Most areas of this soil are farmed. A few areas are still wooded. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to poor potential for recreational development and poor potential for most engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Legumes are subject to winterkill from ponding and ice sheeting. The soil is difficult to work. It is sticky when wet and hard when dry. Seedbeds are difficult to prepare. The soil must be tilled at the proper moisture content to prevent clodding and soil compaction. Wetness often delays tilling and harvesting.

Surface or subsurface drainage is needed in many areas. Timely conservation tillage helps to reduce soil compaction and clodding. Returning crop residue or regularly adding manure improves tilth and increases water infiltration.

If the soil is used as pasture, overgrazing should be avoided. Grazing when the soil is wet compacts the surface. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. Seedling survival can be improved by planting vigorous nursery stock. Brushy vegetation competing with natural regeneration following harvest can be controlled through the use of suitable herbicides, or it can be removed mechanically.

This soil is poorly suited as a septic tank absorption field because of the seasonal high water table and the slow permeability. It is also poorly suited as a building site. If used as a site for dwellings with basements, it should be drained. Because of the low strength and the shrinking and swelling of the soil, foundations and footings should be designed to provide the structural support needed. Local roads and streets should be graded to shed water if they are to function properly, and suitable base materials should be added.

The capability subclass is IIe. The woodland suitability subclass is 2c.

YaA—Yahara silt loam, 0 to 3 percent slopes. This nearly level to gently sloping, somewhat poorly drained soil is on old lake terraces and valley terraces and in upland drainageways. It is subject to occasional flooding or ponding from adjacent higher areas. Areas are long and narrow or irregular in shape. They range from about 5 to 60 acres.

Typically, the surface layer of this Yahara soil is very dark gray silt loam about 10 inches thick. The subsoil is about 14 inches thick. The upper part is yellowish brown and light brownish gray, mottled, very friable silt loam. The lower part is grayish brown, mottled, friable silt loam. The substratum to a depth of about 60 inches is strong brown, mottled, stratified very fine sand and very fine sandy loam. In some areas the surface layer is loam or very fine sandy loam. In some areas the substratum is mostly sand, loamy sand, or silt loam. In some areas the soil contains thin strata of clay. In places this soil is poorly drained.

Included with this soil in mapping are small areas of Korobago soils in landscape positions similar to those of the Yahara soil. They have glacial till at a depth of 20 to 40 inches. These areas make up 2 to 10 percent of the unit.

Permeability is moderate. Surface runoff is slow. Available water capacity is high. Reaction is neutral or mildly alkaline in the subsoil. Free lime occurs in the lower part of the subsoil and in the substratum.

Undrained areas are saturated for long periods at depths of 1 to 3 feet. The response to additions of plant nutrients in undrained areas is limited by the excessive wetness. The surface layer is very friable and can be easily tilled throughout a fairly wide range in moisture content.

Most areas of this soil are farmed. A few are still wooded. The soil has good potential for cultivated crops, hay, pasture, and trees. It has fair to poor potential for recreational development and poor potential for engineering uses.

If drained, this soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Grasses and legumes are subject to winterkill from ponding and ice sheeting. Yields on the undrained soil are limited by the excessive wetness. Surface and subsurface drainage is needed. Subsurface drainage tile is subject to clogging.

This soil is suitable for wood crops. The only soil-related management problem is the competition from brushy vegetation following harvest. Brushy species competing with natural regeneration can be controlled through the use of suitable herbicides or they can be removed mechanically.

This soil is poorly suited as a septic tank absorption field and a building site because of the seasonal high water table and the flood hazard. If used as a building site, it should be drained and protected from flooding. Dwellings should be constructed without basements. Local roads and streets are subject to failure as a result of high frost action. Roads should be graded to shed water if they are to function properly, and suitable base material should be added.

The capability subclass is IIw. The woodland suitability subclass is 2o.

ZtA—Zittau silty clay loam, 0 to 3 percent slopes. This nearly level to gently sloping, somewhat poorly drained soil is in lake basins and on stream terraces. It is subject to occasional flooding or ponding from adjacent higher areas. Areas are long and narrow or irregular in shape. They range from about 5 to 300 acres.

Typically, the surface layer of this Zittau soil is very dark gray silty clay loam about 7 inches thick. The subsurface layer is brown clay about 2 inches thick. The

subsoil is reddish brown, mottled, firm clay about 24 inches thick. The substratum to a depth of about 60 inches is brown, mottled, fine and medium sand. In some areas the sandy substratum contains thin layers of finer textured material. In some areas the surface layer is silt loam or silty clay. In places this soil is poorly drained.

Included with this soil in mapping are small areas of the moderately well drained Borth soils, which are better drained and are in slightly higher landscape positions than those of the Zittau soil. Also included are areas where the surface layer is loamy fine sand or clay. In places the depth to sand is less than 20 inches. In other places it is more than 40 inches. Included areas make up 5 to 15 percent of the unit.

Permeability is slow in the subsoil and rapid in the substratum. Surface runoff is slow. Available water capacity is low or moderate. Reaction ranges from slightly acid to moderately alkaline in the subsoil. The shrink-swell potential is high in the subsoil.

Undrained areas are saturated for long periods at depths of 1 to 3 feet. The response to additions of plant nutrients in undrained areas is limited by the excessive wetness. Tilth is poor.

Most areas of this soil are farmed. A few are still wooded. The soil has fair potential for cultivated crops, hay, and pasture and good potential for trees. It has fair potential for recreational development and poor potential for engineering uses.

This soil is suited to corn, soybeans, and small grain and to grasses and legumes for hay and pasture. Legumes are subject to winterkill from ponding and ice sheeting. The soil is difficult to work. It is sticky when wet and hard when dry. Seedbeds are difficult to prepare. The soil must be tilled at the proper moisture content to prevent clodding and soil compaction. Wetness often delays tilling and harvesting. Yields on the undrained soil are limited by the excessive wetness.

Timely conservation tillage reduces the hazard of soil compaction and clodding. Returning crop residue or regularly adding manure improves tilth and increases water infiltration. Surface and subsurface drainage is needed. Subsurface drainage tile in the sandy substratum is subject to clogging.

If the soil is used as pasture, overgrazing should be avoided. Grazing when the soil is wet compacts the surface layer. Proper stocking, pasture rotation, and restricted use during wet periods help to keep the pasture and the soil in good condition.

This soil is suitable for wood crops. Seedling survival can be improved by planting vigorous nursery stock. Brushy vegetation competing with natural regeneration following harvest can be controlled through the use of suitable herbicides, or it can be removed mechanically.

This soil is suited to construction of the dugout ponds and ditches that provide shallow open water areas. Because the substratum flows if wet, sidewalls of excavations are likely to cave in.

This soil is poorly suited as a septic tank absorption field because of wetness, flooding, and slow permeability. Its potential can be increased by building a filtering mound of suitable material. This soil is poorly suited as a building site. If used as a building site, it should be drained and protected from flooding. Because of the shrinking and swelling in the subsoil, dwellings should be constructed without basements, and foundations and footings should be designed to provide the structural support needed. Because the substratum flows if wet, sidewalls of excavations are likely to cave in. Local roads and streets should be graded to shed water if they are to function properly, and suitable base material should be added.

The capability subclass is IIw. The woodland suitability subclass is 3c.

Use and management of the soils

This soil survey is an inventory and evaluation of the soils in the survey area. It can be used to adjust land uses to the limitations and potentials of natural resources and the environment. Also, it can help avoid soil-related failures in land uses.

In preparing a soil survey, soil scientists, conservationists, engineers, and others collect extensive field data about the nature and behavior characteristics of the soils. They collect data on erosion, droughtiness, flooding, and other factors that affect various soil uses and management. Field experience and collected data on soil properties and performance are used as a basis in predicting soil behavior.

Information in this section can be used to plan the use and management of soils for crops and pasture; as woodland; as sites for buildings, sanitary facilities, highways and other transportation systems, and parks and other recreation facilities; and for wildlife habitat. It can be used to identify the potentials and limitations of each soil for specific land uses and to help prevent construction failures caused by unfavorable soil properties.

Planners and others using soil survey information can evaluate the effect of specific land uses on productivity and on the environment in all or part of the survey area. The survey can help planners to maintain or create a land use pattern in harmony with the natural soil.

Contractors can use this survey to locate sources of sand and gravel, roadfill, and topsoil. They can use it to identify areas where bedrock, wetness, or very firm soil layers can cause difficulty in excavation.

Health officials, highway officials, engineers, and others may also find this survey useful. The survey can help them plan the safe disposal of wastes and locate sites for pavements, sidewalks, campgrounds, playgrounds, lawns, and trees and shrubs.

Crops and pasture

General management needed for crops and pasture is suggested in this section. The crops or pasture plants

best suited to the soils, including some not commonly grown in the survey area, are identified; the system of land capability classification used by the Soil Conservation Service is explained; and the estimated yields of the main crops and hay and pasture plants are listed for each soil.

Planners of management systems for individual fields or farms should consider the detailed information given in the description of each soil under "Soil maps for detailed planning." Specific information can be obtained from the local office of the Soil Conservation Service or the Cooperative Extension Service.

More than 211,000 acres in the survey area was used for crops and pasture in 1967, according to the conservation needs inventory (*10*). About 13,000 acres of this total was permanent pasture. In 1974, according to the Wisconsin Statistical Reporting Service (*12*), 36,000 acres of corn was grown for grain; 18,100 acres of corn silage; 42,000 acres of alfalfa hay; 4,000 acres of other hay; 23,400 acres of oats; 7,200 acres of soybeans; 300 acres of barley; 3,450 acres of wheat; 50 acres of potatoes; 4,000 acres of peas; and 3,550 acres of corn for canning. Some smaller acreages were cropped to rye, mint, sod for lawn turf, truck crops, seed crops, small fruits, tree fruits, flowers, and nursery plants.

The soils of Winnebago County vary in their suitability for specialty crops. Special management is often needed to assure good production. In general, the management needed for a high level of production of specialty crops should be more intensive than the management needed for the commonly grown crops. Fertile soils of high available water capacity, such as Grellton, Plano, and St. Charles soils, are especially well suited to sweet corn, peas, and soybeans. Soils having good tilth but low to moderate available water capacity, such as the sandy soils, are suited to such crops as strawberries, tomatoes, cucumbers, and melons. Organic soils, such as Houghton and Willette soils, are used in growing mint for oil, sod for lawn turf, and truck crops, such as onions and carrots. Most of the well drained soils in the survey area are suited to seed crops, small fruits, tree fruits, flowers, and nursery plants. Apples are the most important tree fruit grown in the county. Soils in low positions where frost is frequent and air drainage is poor generally are poorly suited to early vegetables, small fruits, and tree fruits.

The acreage in crops and pasture has gradually been decreasing as more and more land is used for urban development. In 1975, an estimated 35,400 acres was urban and built-up land. This acreage has been increasing at the rate of about 800 acres per year.

Most of the cropland is used for alfalfa hay, corn, and oats to support the dairying industry. The trend is toward more acreage in corn. The acreage cropped to hay has remained relatively stable since 1900. The acreage in cash grain and vegetable crops has increased slightly in recent years. Oats, wheat, barley, and rye have become less important as cash grain crops. They are grown chiefly as a winter cover crop. Only a small acreage is cropped to potatoes, mint, sod for lawn turf, tree fruits, and small fruits. Soybean production has increased but is now stabilized somewhat.

The potential of the soils in Winnebago County is good for increased crop production. A large part of the 28,600 acres of organic soils, currently in natural vegetation, is suited to a wide range of vegetable crops. Large additions of phosphorus and potassium and controlled drainage are needed to insure good crop growth, alleviate wetness, and control subsidence and soil blowing. If irrigated, the sandy soils in the northwestern part of the county, such as Brems and Oakville, have good potential for increased crop production. Additions of plant nutrients are needed for good growth of crops. These sandy soils also have good potential for growing Christmas trees. A large part of the 20,700 acres in woodland and 13,000 acres in pasture is also potentially good cropland. Food production could also be increased considerably by applying the latest technology to all cropland in the county. This soil survey can greatly facilitate the application of such technology.

Management for the different kinds of soil in Winnebago County varies. Basic management, however, is needed for practically all of the soils, for example, controlling erosion, providing adequate drainage, maintaining fertility, and maintaining and improving tilth.

Soil erosion is a major problem on about one-half the cropland and pasture in Winnebago County. If the slope is more than 2 percent, erosion is generally a hazard. Most of the well drained and moderately well drained soils in the county are subject to erosion. Some of the somewhat poorly drained soils, such as Atterberry, Lamartine, and Manawa, are also subject to erosion if the slope is 2 or 3 percent.

Loss of the surface layer through erosion is damaging for two reasons. First, productivity is reduced as the surface layer is lost and part of the subsoil is incorporated into the plow layer. Loss of the surface layer is especially damaging on soils with a clayey subsoil, such as the Borth, Kaukauna, Kewaunee, Omro, and Winneconne soils, and on soils with a layer in or below the subsoil that limits the depth of the root zone. Such layers include strata of gravel, as in the Casco, Fox, and Lorenzo Variant soils, or bedrock, as in the Knowles, Eleva, Ritchey, and Whalan soils. Erosion also reduces productivity on soils that are droughty, such as Oakville, Puchyan, and Tustin soils. Second, soil erosion results in sediment entering streams and lakes. Control of erosion minimizes the pollution of streams by sediment and improves quality of water for municipal use, recreation, and fish and wildlife.

In many fields, preparing a good seedbed and tilling are difficult on clayey or hardpan spots because the original friable surface soil has been eroded away. Such spots are common in areas of the eroded Casco, Hortonville, Kewaunee, and LeRoy soils.

Erosion control provides protective cover, reduces runoff, increases infiltration, and diverts runoff from criti-

cal areas. A cropping system that keeps a plant cover on the soil for extended periods can hold erosion losses to amounts that will not reduce the productive capacity of the soils. The legume and grass forage crops in the cropping system reduce erosion and also provide nitrogen and improve tilth for the following crop.

Slopes are so short or so irregular that contour tillage or terracing is not practical in many areas of the sloping Casco, Eleva, Fox, Knowles, LeRoy, Ritchey, and Whalan soils. On these soils, a cropping system that provides an adequate plant cover is needed to control erosion. Leaving crop residue on the surface increases infiltration and reduces the hazards of runoff and erosion. This practice can be adapted to most soils in the survey area.

Conservation tillage or no tillage for corn is effective in reducing the erosion hazard on sloping land, but is difficult to use successfully on the eroded soils and on soils that have a high content of clay in the surface layer, such as many Borth, Kaukauna, Kewaunee, Omro, and Winneconne soils. These practices are not common in the survey area but can be applied successfully in the silt-capped Cary drift area in the southwestern part of the county.

Terraces and diversions reduce the length of slope, direct runoff from critical areas, and thus reduce the hazard of runoff and erosion. They are most practical on deep, well drained soils that have regular slopes. Most of the soils in the survey area are poorly suited to terracing and diversions because of irregular slopes, excessive wetness in channels, a clayey subsoil which would be exposed in terrace channels, or bedrock within a depth of 40 inches. Diversions would be highly beneficial in many areas of the county in protecting low-lying areas from the runoff of higher areas.

Grassed waterways remove excess surface water and reduce the risk of erosion on erodible slopes along natural drainageways. They are most practical on deep, well drained soils. Grassed waterways are commonly used in the survey area. Many are tiled. Tiling reduces wetness in the channel, making it easier to cross the channel with farm machinery and easier to establish a plant cover. Establishing grassed waterways is difficult in many soils because of the excessive wetness in the channels, the shallow substratum of raw material or clayey material that would be exposed in terrace channels, or the bedrock, which is within a depth of 40 inches.

Contour tillage and contour stripcropping are also erosion control practices. They allow more intensive cropping on soils subject to water erosion and reduce the risk of erosion by reducing and slowing down runoff. They are best adapted to soils with smooth, uniform slopes. Contour tillage is a widely used practice in the survey area. Contour stripcropping is not commonly used because of the irregular slopes, the short slopes on the steeper soils, and the increasing size of farm machinery.

Soil blowing is a hazard on about 24,998 acres of mineral soils and 23,700 acres of organic soils in the survey area. Those acreages include the Brems, Fisk, Grellton, Kingsville, Morocco, Nebago, Nebago Variant, Oakville, Puchyan, and Tustin soils; the Hortonville, Kewaunee, Kidder, and Whalan soils that have a loamy fine sand surface layer; and the muck soils—Adrian, Edwards, Houghton, Palms, and Willette soils. Soil blowing can damage these soils in a few hours if winds are strong and the soils are dry and bare of vegetation or surface mulch. Maintaining a windbreak, a plant cover, a surface mulch, or a rough surface through proper tillage minimizes the hazard of soil blowing.

Information on the design of erosion control practices for each kind of soil is contained in the Technical Guide, available in local offices of the Soil Conservation Service.

Soil drainage is the major management need on about half the acreage used for crops and pasture in the survey area. Some soils are naturally so wet that the production of crops commonly grown in the area is generally not possible unless the soils are drained. These are the poorly drained and very poorly drained Keowns, Kingsville, Menasha, Navan, Nebago Variant, Ossian, Poy, Poygan, and Wauseon soils, which make up about 39,520 acres in the survey area. Drainage is also needed on the organic soils—the Adrian, Edwards, Houghton, Palms, and Willette soils—which make up about 28,600 acres.

Unless drained, the somewhat poorly drained soils are so wet that crops are damaged during most years. In this category are the Atterberry, Fisk, Korobago, Lamartine, Manawa, Morocco, Mosel, Nebago, Neenah, Nenno, Udorthents, Yahara, and Zittau soils, which make up about 86,400 acres.

Borth, Hortonville, Kaukauna, Kewaunee, Omro, Whalan, and Winneconne soils have adequate drainage most of the year, but they tend to dry out slowly after rains. The wetter Manawa, Menasha, Neenah, Poy, Poygan, Udorthents, and Zittau soils also tend to dry out slowly after rains. Small areas of wetter soils along drainageways and in swales are commonly included in areas of the moderately well drained Borth, Brems, Kaukauna, Kewaunee, and Winneconne soils, especially in areas where the slope is less than 6 percent. Drainage is needed in some of these wetter areas.

The design of both surface and subsurface drainage systems varies with the kind of soil. A combination of surface drainage and tile drainage is needed in most areas of the poorly drained and very poorly drained soils used for intensive row cropping, especially on those soils that have a clayey surface layer or subsoil. Menasha, Poy, and Poygan soils are examples. These soils are highly susceptible to ponding. A surface drainage system provides adequate drainage on most of the wet soils that are used for pasture.

Most of the somewhat poorly drained soils can be adequately drained by tile drainage, especially in areas where the slope is 2 or 3 percent. Some of these soils also need surface drainage to remove excess surface

water during spring runoff and after heavy rains (fig. 4). Manawa, Neenah, and Zittau soils, for example, are highly susceptible to ponding because of a clayey surface layer or subsoil.

Tile drains have to be more closely spaced in slowly permeable soils than in the more permeable soils. Korobago, Manawa, Menasha, Mosel, Navan, Nebago, Nebago Variant, Meenah, Poy, Poygan, Udorthents, Wauseon, Willette, and Zittau soils have clayey layers that are slowly permeable. Finding adequate outlets for tile drainage systems is difficult in many areas of the poorly drained and very poorly drained soils. Many of the wet soils in the county have a high potential frost action. Frost action heaves the soil as freezing progresses and may cause displacement of the tile drains. The potential is highest in soils that have a high content of silt and very fine sand, such as Keowns, Korobago, Wauseon, and Yahara soils. Tile drains should be protected from clogging in soils that have layers of fine sand or very fine sand. The sand will flow when wet and enter the tile drains. Adrian, Fisk, Fluvaquents, Keowns, Kingsville, Korobago, Morocco, Nebago, Nebago Variant, Palms, Poy, Wauseon, Yahara, and Zittau soils have these sand layers.

Diversions are needed to protect many of the soils from the runoff of adjacent uplands. Ditches can also be used to remove excess surface water along with subsurface water. They are especially useful in areas of soils that have unstable sand layers where maintaining tile drains is difficult. These sand layers are also unstable in ditchbanks and frequently cave in when saturated. Cutbanks also cave in the organic soils.

Organic soils oxidize and subside when the pore space is filled with air. Special drainage systems are needed to control the depth and the period of drainage. Keeping the water table at the level required by crops during the growing season and raising it to the surface during other parts of the year minimize the oxidation and subsidence of organic soils.

Many of the organic soils and some of the other wet mineral soils are periodically flooded by stream overflow or overflow from a rise in lake levels. About half the acreage of Houghton soils, for example, is flooded with 1 to 3 feet of water throughout most of the year. These soils are adjacent to streams and lakes. If cropped, they should be protected by a system of dikes. Some of the flooded soils and other wet soils that have no outlet for drainage ditches could be adequately drained through a system of dikes and pumps. Some of these pump systems are now in use in the survey area. Information on drainage design for each kind of soil is contained in the Technical Guide, available in local offices of the Soil Conservation Service.

Figure 4.—Drainage is needed on ponded Atterberry soil to remove excess surface water during spring runoff and after heavy rains.

Soil fertility is naturally low in most of the sandy soils, such as Brems, Kingsville, Morocco, and Oakville soils, and in the organic soils. Regular applications of commercial fertilizer are needed for good growth of crops. The organic Adrian, Edwards, Houghton, Palms, and Willette soils have a low content of phosphorus and potassium. They are also low in boron and trace elements and require special fertilizer to supply these elements. Most of the clayey soils require additions of phosphorus and potassium for good growth of crops.

Deep silty or loamy soils, such as Atterberry, Grellton, Lamartine, Lomira, Ossian, Plano, and St. Charles soils, that have high available water capacity are some of the most fertile soils in the survey area. The use of a cropping system that provides for regular additions of organic matter increases fertility. Applying barnyard manure, plowing under a green crop, returning crop residue to the soil, and adding commercial fertilizer are beneficial practices. Generally, all crops grown on the soils respond well to applications of commercial fertilizer.

The sandy soils, organic soils, and soils of the Cary drift area in the southwestern part of the county commonly are medium acid in the subsoil. The sandy soils in the northwestern part are the most acid soils in the survey area. The upper layers of these sandy soils are strongly acid or very strongly acid in many places, especially in wooded areas. All the acid soils require applications of ground limestone to raise the pH level sufficiently for good growth of alfalfa and other crops that grow best on nearly neutral soils.

The soils that are shallow over sand and gravel or gravelly till—such as Casco, LeRoy, and Lorenzo Variant soils—commonly are mildly alkaline or neutral. Most of the soils in the clayey area of the county, the Valders drift area, have a neutral or mildly alkaline subsoil. On all soils, additions of lime and fertilizer should be based on the results of soil tests, on the need of the crop, and on the expected level of yields. The Cooperative Extension Service can help in determining the kinds and amounts of fertilizer and lime to be applied.

Soil tilth is an important factor in the germination of seeds and in the infiltration of water into the soil. Soils that have good tilth are granular and porous.

About one-third of the soils in the survey area have a silty clay loam, clay loam, or clay surface layer. These soils—Borth, Kaukauna, Kewaunee, Manawa, Menasha, Neenah, Omro, Poy, Poygan, Winneconne, and Zittau soils—have poor tilth. They stay wet until late in spring. If wet when plowed, they tend to be very cloddy when dry and good seedbeds are difficult to prepare. Fall plowing generally results in good structure in spring. Most of these soils are not subject to damaging erosion if they are plowed in fall.

On about 61,500 acres, the surface layer is muck, fine sand, loamy fine sand, loam, or fine sandy loam. These soils have good tilth and are suited to either spring or fall plowing.

On about 122,600 acres, the surface layer is silt loam. Most of these soils are in the southern part of the county. Many of these soils, especially in the southwestern part of the county, have a surface layer that is light in color and low in content of organic matter. Generally these light-colored soils have weak structure, and intense rainfall causes the formation of a crust on the surface. Because the crust is hard when dry, it reduces infiltration and increases runoff. Regular additions of crop residue and manure help to improve soil structure and reduce crust formation. Fall plowing is generally not a good practice on these light-colored soils because of the crust that forms in winter and spring. Many of the soils are nearly as dense and hard at planting time after fall plowing as they were before they were plowed.

Tilth can be maintained or improved by conservation tillage and the use of grasses and legumes in the cropping system, in addition to the input of organic matter to the soil. A good way to minimize tillage is to plow and plant in one operation. Excessive tillage and use of heavy farm machinery compact the soil, especially when the soil is wet.

Shallow soils, such as Casco, Hochheim, LeRoy, and Lorenzo Variant soils, have some included areas where the content of gravel is high in the plow layer. The gravel restricts tillage, and good seedbeds are difficult to prepare. Tillage is also restricted by the rock outcrop in some of the Knowles, Ritchey, and Whalan soils. The outcrop and the gravelly areas are identified by spot symbols on the soil map.

Yields per acre

The average yields per acre that can be expected of the principal crops under a high level of management are shown in table 4. In any given year, yields may be higher or lower than those indicated in the table because of variations in rainfall and other climatic factors.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby counties and results of field trials and demonstrations are also considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green-manure crops; and harvesting that insures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 4 are grown in the survey area, but estimated yields are not listed be-

cause the acreage of such crops is small. The local office of the Soil Conservation Service or of the Cooperative Extension Service can provide information about the management and productivity of the soils.

Land capability classification

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor does it consider possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for woodland and for engineering purposes.

In the capability system, soils are generally grouped at three levels: capability class, subclass, and unit (*7*). Only class and subclass are used in this survey. These levels are defined in the following paragraphs.

Capability classes, the broadest groups, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class I soils have slight limitations that restrict their use.

Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class III soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

Class IV soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class V soils are not likely to erode but have other limitations, impractical to remove, that limit their use.

Class VI soils have severe limitations that make them generally unsuitable for cultivation.

Class VII soils have very severe limitations that make them unsuitable for cultivation.

Class VIII soils and miscellaneous areas have limitations that nearly preclude their use for commercial crop production.

Capability subclasses are soil groups within one class. They are designated by adding a small letter, *e, w, s,* or *c,* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is risk of erosion unless close-growing plant cover is maintained; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); *s* shows that the soil is limited mainly because it is shallow, droughty, or stony; and *c*, used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class I there are no subclasses because the soils of this class have few limitations. Class V contains only the subclasses indicated by *w, s,* or *c* because the soils in class V are subject to little or no erosion. They have other limitations that restrict their use to pasture, woodland, wildlife habitat, or recreation.

The acreage of soils in each capability class and subclass is shown in table 5. The capability classification of each map unit is given in the section "Soil maps for detailed planning."

Woodland management and productivity

George W. Alley, forester, Soil Conservation Service, helped prepare this section.

The vegetation in Winnebago County before agricultural settlement was chiefly forest or oak savannah. There were small areas of sedge meadow or prairie grasses in the northern and western parts of the county. The largest area was oak savannah—open, parklike oak woods intermingled with prairie vegetation. The rest of the forest was southern hardwood or southern oak (*9*).

Most of the original forest has been cleared for farm crops. About 7 percent, some 20,700 acres, is still wooded. The composition by timber types is oak-hickory, 7,500 acres; maple-beech-birch, 6,000 acres; elm-ash-cottonwood, 4,800 acres; and small acreages of aspen-birch and coniferous woods. About 700 acres is classified as nonstocked (*11*).

Because of the small acreage of forest, the economic importance of forestry and forest products is small. Small amounts of sawlogs and round wood are marketed.

Table 6 can be used by woodland owners or forest managers in planning the use of soils for wood crops. Only those soils suitable for wood crops are listed. The table lists the ordination (woodland suitability) symbol for each soil. Soils assigned the same ordination symbol require the same general management and have about the same potential productivity.

The first part of the *ordination symbol*, a number, indicates the potential productivity of the soils for important trees. The number 1 indicates very high productivity; 2, high; 3, moderately high; 4, moderate; and 5, low. The second part of the symbol, a letter, indicates the major kind of soil limitation. The letter *x* indicates stoniness or rockiness; *w*, excessive water in or on the soil; *t*, toxic substances in the soil; *d*, restricted root depth; *c*, clay in the upper part of the soil; *s*, sandy texture; *f*, high content of coarse fragments in the soil profile; and *r*, steep slopes. The letter *o* indicates that limitations or restrictions are insignificant. If a soil has more than one limitation, the priority is as follows: x, w, t, d, c, s, f, and r.

In table 6, *slight, moderate,* and *severe* indicate the degree of the major soil limitations to be considered in management.

Ratings of *equipment limitation* reflect the characteristics and conditions of the soil that restrict use of the equipment generally needed in woodland management or harvesting. A rating of *slight* indicates that use of equipment is not limited to a particular kind of equipment or time of year; *moderate* indicates a short seasonal limitation or a need for some modification in management or in equipment; and *severe* indicates a seasonal limitation, a need for special equipment or management, or a hazard in the use of equipment.

Seedling mortality ratings indicate the degree to which the soil affects the mortality of tree seedlings. Plant competition is not considered in the ratings. The ratings apply to seedlings from good stock that are properly planted during a period of sufficient rainfall. A rating of *slight* indicates that the expected mortality is less than 25 percent; *moderate*, 25 to 50 percent; and *severe*, more than 50 percent.

Ratings of *windthrow hazard* are based on soil characteristics that affect the development of tree roots and the ability of the soil to hold trees firmly. A rating of *slight* indicates that a few trees may be blown down by normal winds; *moderate*, that some trees will be blown down during periods of excessive soil wetness and strong winds; and *severe*, that many trees are blown down during periods of excessive soil wetness and moderate or strong winds.

Ratings of the *erosion hazard* indicate the risk of loss of soil in well managed woodland. The risk is *slight* if the expected soil loss is small, *moderate* if measures are needed to control erosion during logging and road construction, and *severe* if intensive management or special equipment and methods are needed to prevent excessive loss of soil.

The *potential productivity* of merchantable or *common trees* on a soil is expressed as a *site index*. This index is the average height, in feet, that dominant and codominant trees of a given species attain in a specified number of years. The site index applies to fully stocked, even-aged, unmanaged stands. Commonly grown trees are those that woodland managers generally favor in intermediate or improvement cuttings. They are selected on the basis of growth rate, quality, value, and marketability.

Trees to plant are those that are suited to the soils and to commercial wood production.

Additional information about woodland management and productivity can be obtained from the Wisconsin Department of Natural Resources forester, the local office of the Soil Conservation Service, or the Cooperative Extension Service.

Windbreaks and environmental plantings

Windbreaks protect livestock, buildings, and yards from wind and snow. They also protect fruit trees and gardens, and they furnish habitat for wildlife. Several rows of low- and high-growing broadleaf and coniferous trees and shrubs provide the most protection.

Environmental plantings help to beautify and screen houses and other buildings and to abate noise. The plants, mostly evergreen shrubs and trees, are closely spaced. To insure plant survival, a healthy planting stock of suitable species should be planted properly on a well prepared site and maintained in good condition.

Table 7 shows the height that locally grown trees and shrubs are expected to reach in 20 years on various soils. The estimates in table 7 are based on measurements and observation of established plantings that have been given adequate care. They can be used as a guide in planning windbreaks and screens. Additional information on planning windbreaks and screens and planting and caring for trees and shrubs can be obtained from local offices of the Soil Conservation Service or the Cooperative Extension Service or from a nursery or the Wisconsin Department of Natural Resources foresters.

Engineering

Peg S. Whiteside, soil mechanics engineer, Soil Conservation Service, helped prepare this section.

This section provides information for planning land uses related to urban development and to water management. Soils are rated for various uses, and the most limiting features are identified. The ratings are given in the following tables: Building site development, Sanitary facilities, Construction materials, and Water management. The ratings are based on observed performance of the soils and on the estimated data and test data in the "Soil properties" section.

Information in this section is intended for land use planning, for evaluating land use alternatives, and for planning site investigations prior to design and construction. The information, however, has limitations. For example, estimates and other data generally apply only to that part of the soil within a depth of 5 feet. Because of the map scale, small areas of different soils may be included within the mapped areas of a specific soil.

The information is not site specific and does not eliminate the need for onsite investigation of the soils or for testing and analysis by personnel experienced in the design and construction of engineering works.

Government ordinances and regulations that restrict certain land uses or impose specific design criteria were not considered in preparing the information in this section. Local ordinances and regulations need to be considered in planning, in site selection, and in design.

Soil properties, site features, and observed performance were considered in determining the ratings in this section. During the fieldwork for this soil survey, determinations were made about grain-size distribution, liquid limit, plasticity index, soil reaction, depth to bedrock, hardness of bedrock within 5 feet of the surface, soil wetness, depth to a seasonal high water table, slope, likelihood of flooding, natural soil structure aggregation, and soil density. Data were collected about kinds of clay

minerals, mineralogy of the sand and silt fractions, and the kind of adsorbed cations. Estimates were made for erodibility, permeability, corrosivity, shrink-swell potential, available water capacity, and other behavioral characteristics affecting engineering uses.

This information can be used to (1) evaluate the potential of areas for residential, commercial, industrial, and recreation uses; (2) make preliminary estimates of construction conditions; (3) evaluate alternative routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternative sites for sanitary landfills, septic tank absorption fields, and sewage lagoons; (5) plan detailed onsite investigations of soils and geology; (6) locate potential sources of gravel, sand, earthfill, and topsoil; (7) plan drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; and (8) predict performance of proposed small structures and pavements by comparing the performance of existing similar structures on the same or similar soils.

The information in the tables, along with the soil maps, the soil descriptions, and other data provided in this survey can be used to make additional interpretations.

Some of the terms used in this soil survey have a special meaning in soil science and are defined in the Glossary.

Building site development

Table 8 shows the degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, local roads and streets, and lawns and landscaping. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required. Special feasibility studies may be required where the soil limitations are severe.

Shallow excavations are trenches or holes dug to a maximum depth of 5 feet for basements, graves, utility lines, open ditches, and other purposes. The ratings are based on soil properties, site features, and observed performance of the soils. The ease of digging, filling, and compacting is affected by the depth to bedrock, a cemented pan, or a very firm dense layer; stone content; soil texture; and slope. The time of the year that excavations can be made is affected by the depth to a seasonal high water table and the susceptibility of the soil to flooding. The resistance of the excavation walls or banks to sloughing or caving is affected by soil texture and the depth to the water table.

Dwellings and small commercial buildings are structures built on shallow foundations on undisturbed soil. The load limit is the same as that for single-family dwellings no higher than three stories. Ratings are made for small commercial buildings without basements, for dwellings with basements, and for dwellings without basements. The ratings are based on soil properties, site features, and observed performance of the soils. A high water table, flooding, shrink-swell potential, and organic layers can cause the movement of footings. A high water table, depth to bedrock or to a cemented pan, large stones, and flooding affect the ease of excavation and construction. Landscaping and grading that require cuts and fills of more than 5 feet are not considered.

Local roads and streets have an all-weather surface and carry automobile and light truck traffic all year. They have a subgrade of cut or fill soil material, a base of gravel, crushed rock, or stabilized soil material, and a flexible or rigid surface. Cuts and fills are generally limited to less than 6 feet. The ratings are based on soil properties, site features, and observed performance of the soils. Depth to bedrock or to a cemented pan, a high water table, flooding, large stones, and slope affect the ease of excavating and grading. Soil strength (as inferred from the engineering classification of the soil), shrink-swell potential, frost action potential, and depth to a high water table affect the traffic supporting capacity (fig. 5).

Lawns and landscaping require soils on which turf and ornamental trees and shrubs can be established and maintained. The ratings are based on soil properties, site features, and observed performance of the soils. Soil reaction, a high water table, depth to bedrock, and the available water capacity in the upper 40 inches affect plant growth. Flooding, wetness, slope, stoniness, and the amount of sand, clay, or organic matter in the surface layer affect trafficability after vegetation is established.

Sanitary facilities

Table 9 shows the degree and the kind of soil limitations that affect septic tank absorption fields, sewage lagoons, and sanitary landfills. The limitations are considered *slight* if soil properties and site features are generally favorable for the indicated use and limitations are minor and easily overcome; *moderate* if soil properties or site features are not favorable for the indicated use and special planning, design, or maintenance is needed to overcome or minimize the limitations; and *severe* if soil properties or site features are so unfavorable or so difficult to overcome that special design, significant increases in construction costs, and possibly increased maintenance are required.

Table 9 also shows the suitability of the soils for use as daily cover for landfills. A rating of *good* indicates that soil properties and site features are favorable for the use and good performance and low maintenance can be expected; *fair* indicates that soil properties and site fea-

Figure 5.—Keowns soil has a poor traffic supporting capacity because of high potential frost action and resulting frost heave.

tures are moderately favorable for the use and one or more soil properties or site features make the soil less desirable than the soils rated good; and *poor* indicates that one or more soil properties or site features are unfavorable for the use and overcoming the unfavorable properties requires special design, extra maintenance, or costly alteration.

Septic tank absorption fields are areas in which effluent from a septic tank is distributed into the soil through subsurface tiles or perforated pipe. Only that part of the soil between depths of 18 and 60 inches is evaluated. The ratings are based on soil properties, site features, and observed performance of the soils. Permeability, a high water table, depth to bedrock, and flooding affect absorption of the effluent. Large stones and bedrock interfere with installation.

Unsatisfactory performance of septic tank absorption fields, including excessively slow absorption of effluent, surfacing of effluent, and hillside seepage, can affect public health. Ground water can be polluted if highly permeable sand and gravel or fractured bedrock is less than 3 feet below the base of the absorption field, if slope is excessive, or if the water table is near the surface. There must be unsaturated soil material beneath the absorption field to effectively filter the effluent. Many local ordinances require that this material be of a certain thickness.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons should have a nearly level floor surrounded by cut slopes or embankments of compacted soil. Lagoons generally are designed to hold the sewage within a depth of 2 to 5 feet. Nearly impervious soil material for the lagoon floor and sides is required to minimize seepage and contamination of ground water.

Table 9 gives ratings for the natural soil that makes up the lagoon floor. The surface layer and, generally, 1 or 2 feet of soil material below the surface layer are excavated to provide material for the embankments. The ratings are based on soil properties, site features, and observed performance of the soils. Considered in the ratings are slope, permeability, a high water table, depth to bedrock or to a cemented pan, flooding, large stones, and content of organic matter.

Excessive seepage due to rapid permeability of the soil or a water table that is high enough to raise the level of sewage in the lagoon causes a lagoon to function unsatisfactorily. Pollution results if seepage is excessive or if floodwater overtops the lagoon. A high content of organic matter is detrimental to proper functioning of the lagoon because it inhibits aerobic activity. Slope, bedrock, and cemented pans can cause construction problems, and large stones can hinder compaction of the lagoon floor.

Sanitary landfills are areas where solid waste is disposed of by burying it in soil. There are two types of landfill—trench and area. In a trench landfill, the waste is placed in a trench. It is spread, compacted, and covered daily with a thin layer of soil excavated at the site. In an area landfill, the waste is placed in successive layers on the surface of the soil. The waste is spread, compacted, and covered daily with a thin layer of soil from a source away from the site.

Both types of landfill must be able to bear heavy vehicular traffic. Both types involve a risk of ground water pollution. Ease of excavation and revegetation needs to be considered.

The ratings in table 9 are based on soil properties, site features, and observed performance of the soils. Permeability, depth to bedrock, a high water table, slope, and flooding affect both types of landfill. Texture, stones and boulders, highly organic layers, and soil reaction affect trench type landfills. Unless otherwise stated, the ratings apply only to that part of the soil within a depth of about 5 feet. For deeper trenches, a limitation rated slight or moderate may not be valid. Onsite investigation is needed.

Daily cover for landfill is the soil material that is used to cover compacted solid waste in an area type sanitary landfill. The soil material is obtained offsite, transported to the landfill, and spread over the waste.

Soil texture, wetness, coarse fragments, and slope affect the ease of removing and spreading the material during wet and dry periods. Loamy or silty soils that are free of large stones or excess gravel are the best cover for a landfill. Clayey soils are sticky or cloddy and are difficult to spread; sandy soils are subject to soil blowing.

After soil material has been removed, the soil material remaining in the borrow area must be thick enough over bedrock, a cemented pan, or the water table to permit revegetation. The soil material used as final cover for a landfill should be suitable for plants. The surface layer generally has the best workability, more organic matter, and the best potential for plants. Material from the surface layer should be stockpiled for use as the final cover.

Construction materials

Table 10 gives information about the soils as a source of roadfill, sand, gravel, and topsoil. The soils are rated *good, fair,* or *poor* as a source of roadfill, topsoil, sand, and gravel. The ratings are based on soil properties and site features that affect the removal of the soil and its use as construction material. Normal compaction, minor processing, and other standard construction practices are assumed. Each soil is evaluated to a depth of 5 feet.

Roadfill is soil material that is excavated in one place and used in road embankments in another place. In this table, the soils are rated as a source of roadfill for low embankments, generally less than 6 feet high and less exacting in design than higher embankments.

The ratings are for the soil material below the surface layer to a depth of 5 feet. It is assumed that soil layers will be mixed during excavating and spreading. Many soils have layers of contrasting suitability within their profile. The table showing engineering properties provides detailed information about each soil layer. This information can help determine the suitability of each layer for use as roadfill. The performance of soil after it is stabilized with lime or cement is not considered in the ratings.

The ratings are based on soil properties, site features, and observed performance of the soils. The thickness of suitable material is a major consideration. The ease of excavation is affected by large stones, a high water table, and slope. How well the soil performs in place after it has been compacted and drained is determined by its strength (as inferred from the engineering classification of the soil) and shrink-swell potential.

Soils rated *good* contain significant amounts of sand or gravel or both. They have at least 5 feet of suitable

material, low shrink-swell potential, few cobbles and stones, and slopes of 15 percent or less. Depth to the water table is more than 3 feet. Soils rated *fair* are more than 35 percent silt- and clay-sized particles and have a plasticity index of less than 10. They have moderate shrink-swell potential, slopes of 15 to 25 percent, or many stones. Depth to the water table is 1 to 3 feet. Soils rated *poor* have a plasticity index of more than 10, a high shrink-swell potential, many stones, or slopes of more than 25 percent. They are wet, and the depth to the water table is less than 1 foot. They may have layers of suitable material, but the material is less than 3 feet thick.

Sand and *gravel* are used in great quantities in many kinds of construction. The ratings in table 10 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 5 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 14.

Topsoil is used to cover an area so that vegetation can be established and maintained. The upper 40 inches of a soil is evaluated for use as topsoil. Also evaluated is the reclamation potential of the borrow area.

Plant growth is affected by toxic material and by such properties as soil reaction, available water capacity, and fertility. The ease of excavating, loading, and spreading is affected by rock fragments, slope, a water table, soil texture, and thickness of suitable material. Reclamation of the borrow area is affected by slope, a water table, rock fragments, bedrock, and toxic material.

Soils rated *good* have friable loamy material to a depth of at least 40 inches. They are free of stones and cobbles, have little or no gravel, and have slopes of less than 8 percent. They are naturally fertile or respond well to fertilizer and are not so wet that excavation is difficult.

Soils rated *fair* are sandy soils, loamy soils that have a relatively high content of clay, soils that have only 20 to 40 inches of suitable material, soils that have an appreciable amount of gravel or stones, or soils that have slopes of 8 to 16 percent. The soils are not so wet that excavation is difficult.

Soils rated *poor* are very sandy or clayey, have less than 20 inches of suitable material, have a large amount of gravel or stones, have slopes of more than 15 percent, or have a seasonal water table at or near the surface.

The surface layer of most soils is generally preferred for topsoil because of its organic matter content. Organic matter greatly increases the absorption and retention of moisture and nutrients for plant growth.

Water management

Table 11 gives information on the soil properties and site features that affect water management. The soil and site features that affect use are given for pond reservoir areas; embankments, dikes, and levees; and aquifer-fed ponds.

This table also gives for each soil the restrictive features that affect drainage, terraces and diversions, and grassed waterways.

Pond reservoir areas hold water behind a dam or embankment. Soils best suited to this use have low seepage potential in the upper 60 inches. The seepage potential is determined by the permeability of the soil and the depth to fractured bedrock or other permeable material. Excessive slope can affect the storage capacity of the reservoir area.

Embankments, dikes, and levees are raised structures of soil material, generally less than 20 feet high, constructed to impound water or to protect land against overflow. In this table, the soils are rated as a source of material for embankment fill. The ratings apply to the soil material below the surface layer to a depth of about 5 feet. It is assumed that soil layers will be uniformly mixed and compacted during construction.

The ratings do not indicate the ability of the natural soil to support an embankment. Soil properties to a depth even greater than the height of the embankment can affect performance and safety of the embankment. Generally, deeper onsite investigation is needed to determine these properties.

Soil material in embankments must be resistant to seepage, piping, and erosion and have favorable compaction characteristics. Unfavorable features include less than 5 feet of suitable material and a high content of stones or boulders or organic matter. A high water table affects the amount of usable material. It also affects trafficability.

Aquifer-fed excavated ponds are pits or dugouts that extend to a ground-water aquifer or to a depth below a permanent water table. Excluded are ponds that are fed only by surface runoff and embankment ponds that impound water 3 feet or more above the original surface. Excavated ponds are affected by depth to a permanent water table, permeability of the aquifer, and quality of the water as inferred from the alkalinity of the soil. Depth to bedrock and the content of large stones affect the ease of excavation.

Drainage is the removal of excess surface and subsurface water from the soil. How easily and effectively the soil is drained depends on the depth to bedrock or to other layers that affect the rate of water movement; permeability; depth to a high water table or depth of standing water if the soil is subject to ponding; slope; susceptibility to flooding; subsidence of organic layers;

and potential frost action. Excavating and grading and the stability of ditchbanks are affected by depth to bedrock, large stones, slope, and the hazard of cutbanks caving. Availability of drainage outlets is not considered in the ratings.

Terraces and diversions are embankments or a combination of channels and ridges constructed across a slope to reduce erosion and conserve moisture by intercepting runoff. Slope, wetness, large stones, and depth to bedrock affect the construction of terraces and diversions. A restricted rooting depth, a severe hazard of wind or water erosion, an excessively coarse texture, and restricted permeability adversely affect maintenance.

Grassed waterways are natural or constructed channels, generally broad and shallow, that conduct surface water to outlets at a nonerosive velocity. Large stones, wetness, slope, and depth to bedrock affect the construction of grassed waterways. A hazard of wind erosion, low available water capacity, restricted rooting depth, and restricted permeability adversely affect the growth and maintenance of the grass after construction.

Recreation

Recreation is of considerable importance in Winnebago County. In 1970, the population was 130,011, of which 70 percent was classified as urban. It is concentrated largely in the eastern part of the county, which is part of the highly industrialized Fox River Valley. The population density of about 287 per square mile is more than triple the state average. The growth rate between 1960 and 1970 was 20.5 percent, almost twice the state average.

The excellent highway system provides easy access from population concentrations in Madison, Milwaukee, Chicago, and the Fox River Valley. The attraction of the large expanses of water in the county greatly increases the summer population. Many recreation facilities are needed to accommodate not only the local population but also the influx in summer.

Winnebago County has more surface water area than any other county in Wisconsin. About 23 percent of the county, or 84,000 acres, is covered with water. Most of this acreage is the largest lakes—Lake Winnebago, Big Lake Buttes des Morts, Lake Winneconne, Lake Poygan, Little Lake Buttes des Morts, and Rush Lake—and the Fox and Wolf Rivers. These rivers and lakes provide many miles of water frontage. Much of it is developed and is the site of many cottages, summer homes, and year-round homes. It is also used for public hunting grounds, boat landings, parks, and campgrounds. Water activities include boating, swimming, and fishing in summer and skating, ice boating, ice fishing, and snowmobiling in winter. The Fox and Wolf Rivers, in particular, are heavily fished in spring when walleye and white bass make their annual spawning run up the rivers.

Winnebago County is generously endowed with wildlife and fish habitat. The preservation of these areas is vitally important for the reproduction of waterfowl and game and the support of fisheries. Preserving these areas as hunting grounds is also important.

The county has a large number of archeological sites, including Indian mounds, campsites, village sites, and cemeteries. All should be explored, evaluated, and perhaps preserved within recreational areas.

There are no state parks in the county. The State of Wisconsin owns about 5,000 acres of public hunting and fishing grounds in the county. Most of this acreage is in the Rat and Wolf River Wildlife Area. These grounds are available for hunting, fishing, hiking, nature study, snowmobiling, sightseeing, and snowskiing. In addition, there are about 11 county parks and many local parks that provide recreational facilities, such as playgrounds, picnic areas, swimming areas, and baseball diamonds. There are also 11 golf courses, 62 public and 1,200 private boat ramps, and 315 campsites in the county. The campsites occur in one public campground and in four private campgrounds.

According to a 1977 plan for parks, open spaces, and outdoor recreation for Winnebago County, more recreational opportunities are needed for the adult population. More land and facilities are needed for bicycle trails, snowmobile trails, nature study, snowshoeing, cross country skiing, boat launching, camping, swimming, horseback riding, and hunting. The plan shows that the county should expand its parkland acreage to provide the open landscape necessary for the adequate development and support of the many recreational needs. Winnebago County should establish an additional 1,865 acres of open space and the State of Wisconsin an additional 7,996 acres by 1990, according to the plan.

The soils of the survey area are rated in table 12 according to limitations that affect their suitability for recreation. The ratings are based on restrictive soil features, such as wetness, slope, and texture of the surface layer. Susceptibility to flooding is considered. Not considered in the ratings, but important in evaluating a site, are the location and accessibility of the area, the size and shape of the area and its scenic quality, vegetation, access to water, potential water impoundment sites, and access to public sewerlines. The capacity of the soil to absorb septic tank effluent and the ability of the soil to support vegetation are also important. Soils subject to flooding are limited for recreation use by the duration and intensity of flooding and the season when flooding occurs. In planning recreation facilities, onsite assessment of the height, duration, intensity, and frequency of flooding is essential.

In table 12, the degree of soil limitation is expressed as slight, moderate, or severe. *Slight* means that soil properties are generally favorable and that limitations are minor and easily overcome. *Moderate* means that limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive

maintenance, limited use, or by a combination of these measures.

The information in table 12 can be supplemented by other information in this survey, for example, interpretations for septic tank absorption fields in table 9 and interpretations for dwellings without basements and for local roads and streets in table 8.

Camp areas require site preparation such as shaping and leveling the tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing campsites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones and boulders, is firm after rains, and is not dusty when dry. If grading is needed, the depth of the soil over bedrock or a hardpan should be considered.

Paths and trails for hiking, horseback riding, and bicycling should require little or no cutting and filling. The best soils are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once a year during the period of use. They have moderate slopes and few or no stones or boulders on the surface.

Golf fairways are subject to heavy foot traffic and some light vehicular traffic. Cutting or filling may be required. The best soils for use as golf fairways are firm when wet, are not dusty when dry, and are not subject to prolonged flooding during the period of use. They have moderate slopes and no stones or boulders on the surface. The suitability of the soil for tees or greens is not considered in rating the soils.

Wildlife habitat

Steve F. Baima, biologist, Soil Conservation Service, helped prepare this section.

Wildlife is a product of the soil. Like other crops, wildlife responds to good management. Usually the level of production of adapted wildlife is in balance with available essential habitat elements—food, cover, and water. The kind of soil directly affects the kind and amount of vegetation, both introduced and native, available to wildlife as food and cover. The kind of soil also affects the construction of ponds and wetland habitat development.

In table 13, the soils in the survey area are rated according to their potential for providing habitat for various kinds of wildlife. This information can be used in planning parks, wildlife refuges, nature study areas, and other developments for wildlife; in selecting soils that are suitable for establishing, improving, or maintaining specific elements of wildlife habitat; and in determining the intensity of management needed for each element of the habitat.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* indicates that the element or kind of habitat is easily established, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected. A rating of *fair* indicates that the element or kind of habitat can be established, improved, or maintained in most places. Moderately intensive management is required for satisfactory results. A rating of *poor* indicates that limitations are severe for the designated element or kind of habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and must be intensive. A rating of *very poor* indicates that restrictions for the element or kind of habitat are very severe and that unsatisfactory results can be expected. Creating, improving, or maintaining habitat is impractical or impossible.

The elements of wildlife habitat are described in the following paragraphs.

Grain and seed crops are domestic grains and seed-producing herbaceous plants. Soil properties and features that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of grain and seed crops are corn, wheat, oats, and barley.

Grasses and legumes are domestic perennial grasses and herbaceous legumes. Soil properties and features that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations. Examples of grasses and legumes are fescue, timothy, bromegrass, clover, and alfalfa.

Wild herbaceous plants are native or naturally established dry-land grasses and forbs. Soil properties and features that affect the growth of these plants are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations. Examples of wild herbaceous plants are bluestem, goldenrod, switchgrass, Indiangrass, beggarstick, and curled dock.

Hardwood trees and woody understory produce nuts or other fruit, buds, catkins, twigs, bark, and foliage. Soil properties and features that affect the growth of hard-

wood trees and shrubs are depth of the root zone, the available water capacity, and wetness. Examples of these plants are oak, poplar, cherry, apple, hawthorn, dogwood, hickory, and blackberry. Examples of fruit-producing shrubs that are suitable for planting on soils rated *good* are Russian-olive, autumn-olive, and crabapple.

Coniferous plants furnish browse, seeds, and cones. Soil properties and features that affect the growth of coniferous trees, shrubs, and ground cover are depth of the root zone, available water capacity, and wetness. Examples of coniferous plants are pine, spruce, fir, cedar, and juniper.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites. Submerged or floating aquatic plants are excluded. Soil properties and features affecting wetland plants are texture of the surface layer, wetness, reaction, slope, and surface stoniness. Examples of wetland plants are smartweed, wild millet, wildrice, cordgrass, rushes, sedges, and reeds.

Shallow water areas have an average depth of less than 5 feet. Some are naturally wet areas. Others are created by dams, levees, or other water-control structures. Soil properties and features affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. Examples of shallow water areas are marshes, waterfowl feeding areas, and ponds.

The habitat for various kinds of wildlife is described in the following paragraphs.

Habitat for openland wildlife consists of cropland, pasture, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The wildlife attracted to these areas include pheasant, Hungarian partridge, meadowlark, field sparrow, cottontail, and red fox.

Habitat for woodland wildlife consists of areas of deciduous plants or coniferous plants or both and associated grasses, legumes, and wild herbaceous plants. Wildlife attracted to these areas include ruffed grouse, woodcock, thrushes, woodpeckers, squirrels, raccoon, and deer.

Habitat for wetland wildlife consists of open, marshy or swampy shallow water areas. Some of the wildlife attracted to such areas are ducks, geese, herons, shore birds, muskrat, mink, and beaver.

The essential habitat elements for a selected species of wildlife generally depend on several kinds of soil and commonly on a combination of land uses. For this reason the map units in this county described under "General soil map for broad land-use planning" are grouped into three wildlife areas.

In the following paragraphs, the groupings of the map units in Winnebago County are described as wildlife areas. These areas differ according to the species that inhabit the areas and the potential of the area for habitat development. Within Winnebago County there are discernible wildlife areas, but the true value of each area depends on how it is interspersed with the other areas. The diversity of wildlife in the county, therefore, depends on the diversity of soils, the land use, and the management in all wildlife areas.

Wildlife area 1

Wildlife area 1 consists of the Kewaunee-Manawa-Hortonville, LeRoy-Ossian-Lomira, Kidder-McHenry, and Plano map units. The glaciated uplands of the county are in this area. Most of the soils are well drained or moderately well drained.

This wildlife area makes up about 73 percent of the county. Most of the acreage is cropland. About 55 percent of the woodland in the county, however, is in this wildlife area.

Grain and seed crops and alfalfa hay are the chief habitat elements in the area. Scattered farm woodlots provide important habitat diversity but make up only 5 percent of the area. No woodlots are on the Plano unit.

Wetlands are not a prominent feature of area 1. Type 2 wetlands, described as inland fresh meadows, are common along the drainageways, but most have been drained and are now used as cropland (*5*). Dugout ponds are in some low areas but are not extensive. Ducks use these ponds for brooding if nesting cover is nearby. Type 1 wetlands, described as seasonally flooded basins and flats, are fairly extensive in swales throughout this area. Type 1 wetlands, normally used as cropland, are extremely important to migrating waterfowl for resting and feeding. Pairing for the oncoming breeding season often occurs during migration when large concentrations of waterfowl gather in type 1 wetlands. Some low wooded areas, considered as type 1 wetlands, occur but are inextensive.

Upland wildlife is predominant in wildlife area 1. Major game species are pheasant, Hungarian partridge, and cottontail. Limited numbers of gray squirrel, fox squirrel, deer, and ruffed grouse inhabit the wooded or brushy areas. Waterfowl use cropland for feeding in some locations. Mallards and blue winged teal nest in areas adjacent to open water. Numerous nongame species, particularly songbirds, are abundant in woodlots and along the edges of adjoining habitat.

Wildlife area 2

Wildlife area 2 consists of the Zittau-Poy and Houghton-Willette map units. This area, an old glacial lake basin, consists of most of the lowlands in the county. Most of the soils have a seasonal high water table.

This wildlife area is about 25 percent of the county. Most of the Houghton-Willette unit is under natural vegetation. Some small areas are pasture or cropland. Fairly extensive areas of the Zittau-Poy unit are pasture or cropland. About 38 percent of the woodland in the county is in this wildlife area, chiefly within the Zittau-Poy unit.

Wetlands are the dominant natural feature throughout this wildlife area, particularly on the Houghton-Willette map unit. The principal habitat elements are cattails, rushes, sedges, grasses, and redosier brush. Some small areas are wooded swamps, or type 7 wetlands. Brushy areas, which are classified as type 6 wetlands and are fairly extensive, are intermixed in many places with type 3 wetlands, described as inland shallow fresh marshes. Approximately 5,000 acres of the Houghton-Willette unit are type 4 wetlands, described as inland deep fresh marshes. These deep marshes, covered with 6 inches to 36 inches of water most of the year, are vegetated mainly by cattails and rushes. They contain many small open water areas. Most of these deep marshes border the lakes and rivers in the county. Type 2 wetlands, the inland fresh meadows, are predominant in the Zittau-Poy unit. Many have been drained and are used for crops or pasture. Grain and seed crops are the principal habitat elements in these drained areas. Woodland makes up 15 percent, or about 7,800 acres, of the Zittau-Poy unit. Much of it borders the marshy areas of the Houghton-Willette unit and provides important habitat diversity.

Wildlife area 2 has many dugout ponds, level ditches, and other open water areas important to waterfowl and fur-bearing animals. In addition, most of the major rivers and lakes in the county are within or adjacent to this area. Wildlife area 2 is only about one-third as large as wildlife area 1, but overall it has a greater diversity and interspersion of habitat elements.

A wide variety of wildlife occurs in wildlife area 2. Waterfowl and fur-bearing animals are the most important. The numerous wetlands of types 2 through 7 provide excellent habitat for mallard, blue winged teal, wood duck, muskrat, raccoon, and mink. Other important game and nongame species in the area include pheasant, deer, Hungarian partridge, ruffed grouse, fox squirrel, gray squirrel, woodcock, Wilson's snipe, and numerous songbirds. The intermixture of brushy areas and marshy areas in the Houghton-Willette unit is heavily used as winter habitat by such species as deer, cottontail, and pheasant.

Wildlife area 3

Wildlife area 3 consists of the Oakville-Brems-Morocco map unit, which is singled out as a specific wildlife area because of its sandy soils. It consists of a glacial lake beach and an outwash plain. Most of the sandy soils have been reworked by wind. The major soils range from well drained to somewhat poorly drained.

This wildlife area makes up only 2 percent of the county, but it supports 7 percent of the woodland in the county. Most of the area is pasture or cropland.

The sandy soils are severely limited for potential land use and habitat development. The soils and the habitat elements they support are subject to seasonal extremes of drought and to a high water table. The principal habitat elements are trees, hay, and grain and seed crops. Scattered farm woodlots make up 25 percent of the area. Some of the better drained soils support pine plantations, but they have limited habitat value. Diversity for wildlife is afforded by the crop and pasture rotation. The percentage of wetland is low. Some type 2 wetland, inland fresh meadows, occurs along drainageways and in swales.

Wildlife common to the area are essentially the same species that inhabit wildlife area 1. Deer and squirrel are particularly abundant. Mourning doves, which are attracted to pine plantations as nesting sites, are common. The pocket gopher is a small mammal characteristically found in areas that are dominantly sandy.

Soil properties

Data relating to soil properties are collected during the course of the soil survey. The data and the estimates of soil and water features, listed in tables, are explained on the following pages.

Soil properties are determined by field examination of the soils and by laboratory index testing of some benchmark soils. Established standard procedures are followed. During the survey, many shallow borings are made and examined to identify and classify the soils and to delineate them on the soil maps. Samples are taken from some typical profiles and tested in the laboratory to determine grain-size distribution, plasticity, and compaction characteristics. These results are reported in table 17.

Estimates of soil properties are based on field examinations, on laboratory tests of samples from the survey area, and on laboratory tests of samples of similar soils in nearby areas. Tests verify field observations, verify properties that cannot be estimated accurately by field observation, and help characterize key soils.

The estimates of soil properties shown in the tables include the range of grain-size distribution and Atterberg limits, the engineering classifications, and the physical and chemical properties of the major layers of each soil. Pertinent soil and water features also are given.

Engineering properties

Table 14 gives estimates of the engineering classification and of the range of index properties for the major layers of each soil in the survey area. Most soils have layers of contrasting properties within the upper 5 feet.

Depth to the upper and lower boundaries of each layer is indicated. The range in depth and information on other properties of each layer are given for each soil series under "Soil series and morphology."

Texture is given in the standard terms used by the U.S. Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in the fraction of the soil that is less than 2 millimeters in diameter. "Loam," for example, is soil that is 7 to 27

percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains particles coarser than sand, an appropriate modifier is added, for example, "gravelly." Textural terms are defined in the Glossary.

Classification of the soils is determined according to the Unified soil classification system (*2*) and the system adopted by the American Association of State Highway and Transportation Officials (*1*).

The Unified system classifies soils according to properties that affect their use as construction material (*2*). Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter and according to plasticity index, liquid limit, and organic matter content. Sandy and gravelly soils are identified as GW, GP, GM, GC, SW, SP, SM, and SC; silty and clayey soils as ML, CL, OL, MH, CH, and OH; and highly organic soils as Pt. Soils exhibiting engineering properties of two groups can have a dual classification, for example, SP-SM.

The AASHTO system classifies soils according to those properties that affect roadway construction and maintenance (*1*). In this system, the fraction of a mineral soil that is less than 3 inches in diameter is classified in one of seven groups from A-1 through A-7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A-1 are coarse grained and low in content of fines (silt and clay). At the other extreme, soils in group A-7 are fine grained. Highly organic soils are classified in group A-8 on the basis of visual inspection.

If laboratory data are available, the A-1, A-2, and A-7 groups are further classified as A-1-a, A-1-b, A-2-4, A-2-5, A-2-6, A-2-7, A-7-5, or A-7-6. As an additional refinement, the suitability of a soil as subgrade material can be indicated by a group index number. Group index numbers range from 0 for the best subgrade material to 20 or higher for the poorest. The AASHTO classification for soils tested, with group index numbers in parentheses, is given in table 17.

Rock fragments larger than 3 inches in diameter are indicated as a percentage of the total soil on a dry-weight basis. The percentages are estimates determined mainly by converting volume percentage in the field to weight percentage.

Percentage (of soil particles) passing designated sieves is the percentage of the soil fraction less than 3 inches in diameter based on an oven-dry weight. The sieves, numbers 4, 10, 40, and 200 (USA Standard Series), have openings of 4.76, 2.00, 0.420, and 0.074 millimeters, respectively. Estimates are based on laboratory tests of soils sampled in the survey area and in nearby areas and on estimates made in the field.

Liquid limit and *plasticity index* (Atterberg limits) indicate the plasticity characteristics of a soil. The estimates are based on test data from the survey area or from nearby areas and on field examination.

Physical and chemical properties

Table 15 shows estimates of some characteristics and features that affect soil behavior. These estimates are given for the major layers of each soil in the survey area. The estimates are based on field observations and on test data for these and similar soils.

Permeability refers to the ability of a soil to transmit water or air. The estimates indicate the rate of downward movement of water when the soil is saturated. They are based on soil characteristics observed in the field, particularly structure, porosity, and texture. Permeability is considered in the design of soil drainage systems, septic tank absorption fields, and construction where the rate of water movement under saturated conditions affects behavior.

Available water capacity refers to the quantity of water that the soil is capable of storing for use by plants. The capacity for water storage is given in inches of water per inch of soil for each major soil layer. The capacity varies, depending on soil properties that affect the retention of water and the depth of the root zone. The most important properties are the content of organic matter, soil texture, bulk density, and soil structure. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design and management of irrigation systems. Available water capacity is not an estimate of the quantity of water actually available to plants at any given time.

Soil reaction is a measure of acidity or alkalinity and is expressed as a range in pH values. The range in pH of each major horizon is based on many field tests. For many soils, values have been verified by laboratory analyses. Soil reaction is important in selecting crops and other plants, in evaluating soil amendments for fertility and stabilization, and in determining the risk of corrosion.

Shrink-swell potential is the potential for volume change in a soil with a loss or gain in moisture. Volume change occurs mainly because of the interaction of clay minerals with water and varies with the amount and type of clay minerals in the soil. The size of the load on the soil and the magnitude of the change in soil moisture content influence the amount of swelling of soils in place. Laboratory measurements of swelling of undisturbed clods were made for many soils. For others, swelling was estimated on the basis of the kind and amount of clay minerals in the soil and on measurements of similar soils.

If the shrink-swell potential is rated moderate to very high, shrinking and swelling can cause damage to buildings, roads, and other structures. Special design is often needed.

Shrink-swell potential classes are based on the change in length of an unconfined clod as moisture content is increased from air-dry to field capacity. The change is based on the soil fraction less than 2 millimeters in diameter. The classes are *low*, a change of less than 3 percent; *moderate*, 3 to 6 percent; and *high*, more

than 6 percent. *Very high*, greater than 9 percent, is sometimes used.

Erosion factor K indicates the susceptibility of a soil to sheet and rill erosion by water. Factor K is one of six factors used in the Universal Soil Loss Equation (USLE) to predict the average annual rate of soil loss by sheet and rill erosion in tons per acre per year. The estimates are based primarily on percentage of silt, sand, and organic matter (up to 4 percent) and on soil structure and permeability. Values of K range from 0.05 to 0.69. The higher the value the more susceptible the soil is to sheet and rill erosion by water.

Erosion factor T is an estimate of the maximum average annual rate of soil erosion by wind or water that can occur without affecting crop productivity over a sustained period. The rate is in tons per acre per year.

Wind erodibility groups are made up of soils that have similar properties affecting their resistance to wind erosion in cultivated areas. The groups indicate the susceptibility of soil to wind erosion and the amount of soil lost. Soils are grouped according to the following distinctions:

1. Sands, coarse sands, fine sands, and very fine sands. These soils are generally not suitable for crops. They are extremely erodible, and vegetation is difficult to establish.

2. Loamy sands, loamy fine sands, and loamy very fine sands. These soils are very highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

3. Sandy loams, coarse sandy loams, fine sandy loams, and very fine sandy loams. These soils are highly erodible. Crops can be grown if intensive measures to control wind erosion are used.

4L. Calcareous loamy soils that are less than 35 percent clay and more than 5 percent finely divided calcium carbonate. These soils are erodible. Crops can be grown if intensive measures to control wind erosion are used.

4. Clays, silty clays, clay loams, and silty clay loams that are more than 35 percent clay. These soils are moderately erodible. Crops can be grown if measures to control wind erosion are used.

5. Loamy soils that are less than 18 percent clay and less than 5 percent finely divided calcium carbonate and sandy clay loams and sandy clays that are less than 5 percent finely divided calcium carbonate. These soils are slightly erodible. Crops can be grown if measures to control wind erosion are used.

6. Loamy soils that are 18 to 35 percent clay and less than 5 percent finely divided calcium carbonate, except silty clay loams. These soils are very slightly erodible. Crops can easily be grown.

7. Silty clay loams that are less than 35 percent clay and less than 5 percent finely divided calcium carbonate. These soils are very slightly erodible. Crops can easily be grown.

8. Stony or gravelly soils and other soils not subject to wind erosion.

Soil and water features

Table 16 gives estimates of various soil and water features. The estimates are used in land use planning that involves engineering considerations.

Hydrologic soil groups are used to estimate runoff from precipitation. Soils not protected by vegetation are assigned to one of four groups. They are grouped according to the intake of water when the soils are thoroughly wet and receive precipitation from long-duration storms. Some of the wetter soils are placed in dual groups such as A/D. The first group refers to drained soils, and the second group refers to undrained soils.

The four hydrologic soil groups are:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a permanent high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

Flooding, the temporary inundation of an area, is caused by overflowing streams or by runoff from adjacent slopes. Water standing for short periods after rainfall or snowmelt and water in swamps and marshes is not considered flooding.

Table 16 gives the frequency and duration of flooding and the time of year when flooding is most likely.

Frequency, duration, and probable dates of occurrence are estimated. Frequency is expressed as none, rare, common, occasional, and frequent. *None* means that flooding is not probable; *rare* that it is unlikely but possible under unusual weather conditions; *common* that it is likely under normal conditions; *occasional* that it occurs on an average of once or less in 2 years; and *frequent* that it occurs on an average of more than once in 2 years. Duration is expressed as *very brief* if less than 2 days, *brief* if 2 to 7 days, and *long* if more than 7 days. Probable dates are expressed in months; November-May, for example, means that flooding can occur during the period November through May.

The information is based on evidence in the soil profile, namely thin strata of gravel, sand, silt, or clay depos-

ited by floodwater; irregular decrease in organic matter content with increasing depth; and absence of distinctive horizons that form in soils that are not subject to flooding.

Also considered are local information about the extent and levels of flooding and the relation of each soil on the landscape to historic floods. Information on the extent of flooding based on soil data is less specific than that provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table (seasonal) is the highest level of a saturated zone in the soil in most years. The depth to a seasonal high water table applies to undrained soils. The estimates are based mainly on the evidence of a saturated zone, namely grayish colors or mottles in the soil. Indicated in table 16 are the depth to the seasonal high water table; the kind of water table—that is, perched or apparent; and the months of the year that the water table commonly is high. A water table that is seasonally high for less than 1 month is not indicated in table 16. Only saturated zones within a depth of about 6 feet are indicated.

An apparent water table is a thick zone of free water in the soil. It is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil. An artesian water table is under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole. A perched water table is water standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

Depth to bedrock is shown for all soils that are underlain by bedrock at a depth of 5 feet or less. For many soils, the limited depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and on other observations during the mapping of the soils. The kind of bedrock and its hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200-horsepower tractor, but hard bedrock generally requires blasting.

Potential frost action is the likelihood of upward or lateral expansion of the soil caused by the formation of segregated ice lenses (frost heave) and the subsequent collapse of the soil and loss of strength on thawing. Frost action occurs when moisture moves into the freezing zone of the soil. Temperature, texture, density, permeability, content of organic matter, and depth to the water table are the most important factors considered in evaluating the potential for frost action. It is assumed that the soil is not insulated by vegetation or snow and is not artificially drained. Silty and highly structured clayey soils that have a high water table in winter are most susceptible to frost action. Well drained, very gravelly, or very sandy soils are the least susceptible. Frost heave and low soil strength during thawing cause damage mainly to pavements and other rigid structures.

Risk of corrosion pertains to potential soil-induced electrochemical or chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to such factors as soil moisture, particle-size distribution, acidity, and electrical conductivity of the soil. The rate of corrosion of concrete is based mainly on the sulfate and sodium content, texture, moisture content, and acidity of the soil. Special site examination and design may be needed if the combination of factors creates a severe corrosion environment. The steel in installations that intersect soil boundaries or soil layers is more susceptible to corrosion than steel in installations that are entirely within one kind of soil or within one soil layer.

For uncoated steel, the risk of corrosion, expressed as *low, moderate,* or *high,* is based on soil drainage class, total acidity, electrical resistivity near field capacity, and electrical conductivity of the saturation extract.

For concrete, the risk of corrosion is also expressed as *low*, *moderate*, or *high*. It is based on soil texture, acidity, and amount of sulfates in the saturation extract.

Engineering test data

Table 17 shows laboratory test data for several pedons sampled at carefully selected sites in the survey area. Most of the pedons are typical of the series and are described in the section "Soil series and morphology." The soil samples were tested by the Wisconsin Department of Transportation, Division of Highways.

The testing methods generally are those of the American Association of State Highway and Transportation Officials (AASHTO) or the American Society for Testing and Materials (ASTM).

The tests and methods are: AASHTO classification—M 145 (AASHTO), D 3282 (ASTM); Unified classification—D 2487 (ASTM); Mechanical analysis—T 88 (AASHTO), D 2217 (ASTM); Liquid limit—T 89 (AASHTO), D 423 (ASTM); Plasticity index—T 90 (AASHTO), D 424 (ASTM); and Moisture density, Method A—T 99 (AASHTO), D 698 (ASTM).

Classification of the soils

The system of soil classification used by the National Cooperative Soil Survey has six categories (*8*). Beginning with the broadest, these categories are the order, suborder, great group, subgroup, family, and series. Classification is based on soil properties observed in the field or inferred from those observations or from laboratory measurements. In table 18, the soils of the survey area are classified according to the system. The categories are defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The differences among orders reflect the dominant soil-forming processes and the degree of soil formation. Each order is identified by a word ending in *sol*. An example is Mollisol.

SUBORDER. Each order is divided into suborders primarily on the basis of properties that influence soil genesis and are important to plant growth or properties that reflect the most important variables within the orders. The last syllable in the name of a suborder indicates the order. An example is Aquoll (*Aqu*, meaning water, plus *oll*, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of close similarities in kind, arrangement, and degree of development of pedogenic horizons; soil moisture and temperature regimes; and base status. Each great group is identified by the name of a suborder and by a prefix that indicates a property of the soil. An example is Haplaquolls (*Hapl*, meaning minimal horizonation, plus *aquoll*, the suborder of Mollisols that have an aquic moisture regime).

SUBGROUP. Each great group has a typic subgroup. Other subgroups are intergrades or extragrades. The typic is the central concept of the great group; it is not necessarily the most extensive. Intergrades are transitions to other orders, suborders, or great groups. Extragrades have some properties that are not representative of the great group but do not indicate transitions to any other known kind of soil. Each subgroup is identified by one or more adjectives preceding the name of the great group. The adjective *Typic* identifies the subgroup that typifies the great group. An example is Typic Haplaquolls.

FAMILY. Families are established within a subgroup on the basis of physical and chemical properties and other characteristics that affect management. Mostly the properties are those of horizons below plow depth where there is much biological activity. Among the properties and characteristics considered are particle-size class, mineral content, temperature regime, depth of the root zone, consistence, moisture equivalent, slope, and permanent cracks. A family name consists of the name of a subgroup preceded by terms that indicate soil properties. An example is fine, mixed, mesic Typic Haplaquolls.

SERIES. The series consists of soils that have similar horizons in their profile. The horizons are similar in color, texture, structure, reaction, consistence, mineral and chemical composition, and arrangement in the profile. The texture of the surface layer or of the substratum can differ within a series.

Soil series and morphology

In this section, each soil series recognized in the survey area is described. The descriptions are arranged in alphabetic order.

Characteristics of the soil and the material in which it formed are identified for each series. The soil is compared with similar soils and with nearby soils of other series. A pedon, a small three-dimensional area of soil, that is typical of the series in the survey area is described. The detailed description of each soil horizon follows standards in the Soil Survey Manual (*6*). Unless otherwise stated, colors in the descriptions are for moist soil. Following the pedon description is the range of important characteristics of the soils in the series.

The map units of each soil series are described in the section "Soil maps for detailed planning."

Adrian series

The Adrian series consists of very poorly drained, moderately rapidly permeable soils formed in deposits of organic material over sandy mineral deposits. These soils are in depressional areas and in low areas adjacent to drainageways and lakes. Slopes are 0 to 2 percent.

Adrian soils are similar to Edwards, Houghton, Palms, and Willette soils. All formed in deposits of organic material. Edwards soils are underlain by marl at depths of 16 to 51 inches. Houghton soils have organic materials extending to depths greater than 51 inches. Palms soils have loamy material at depths of 16 to 51 inches that average less than 35 percent clay. Willette soils have clayey or loamy material at depths of 16 to 51 inches that averages more than 35 percent clay.

Typical pedon in an area of Adrian muck, 400 feet east and 250 feet south of northwest corner sec. 30, T. 17 N., R. 15 E.

Oa1—0 to 8 inches; black (N 2/0, broken face and rubbed), black (10YR 2/1, pressed) sapric material; about 5 percent fiber, less than 2 percent rubbed; massive; very friable; primarily herbaceous fiber; sodium pyrophosphate brown (10YR 4/3); medium acid; abrupt smooth boundary.

Oa2—8 to 14 inches; black (N 2/0, broken face and rubbed), black (10YR 2/1, pressed) sapric material; about 8 percent fiber, less than 2 percent rubbed; weak medium subangular blocky structure; very friable; primarily herbaceous fiber; sodium pyrophosphate brown (10YR 5/3); medium acid; abrupt smooth boundary.

Oa3—14 to 22 inches; dark reddish brown (5YR 2/2, broken face), black (10YR 2/1, rubbed and pressed) sapric material; about 10 percent fiber, less than 2 percent rubbed; weak thick platy structure; friable; primarily herbaceous fiber; sodium pyrophosphate pale brown (10YR 6/3); few woody fragments; few very thin strata of sand in lower 2 inches; slightly acid; abrupt smooth boundary.

IIC—22 to 60 inches; grayish brown (10YR 5/2) sand; single grained; loose; mildly alkaline.

The depth to the sandy IIC horizon ranges from 16 to 51 inches. The organic material is primarily herbaceous, but some pedons are as much as 10 percent by volume woody fragments. The organic material ranges from medium acid to mildly alkaline.

The surface tier commonly has 10YR hue or it is neutral, and chroma is 0 to 2 on broken face and

rubbed. The organic part of the subsurface and bottom tiers has 10YR, 7.5YR, 5YR, and N hue, value of 2 or 3, and chroma of 0 through 2. Some pedons contain thin layers of hemic material in these tiers. The organic layer, just above the IIC horizon, is as much as 20 percent by volume mineral material in some pedons. The IIC horizon ranges from slightly acid to moderately alkaline. It is medium or fine sand.

Atterberry series

The Atterberry series consists of somewhat poorly drained, moderately permeable soils formed in thick deposits of silty material. These soils are on valley terraces and in drainageways in the uplands. Slopes are 0 to 3 percent.

Atterberry soils formed in the same kind of material as nearby Lamartine, Ossian, and St. Charles soils. The somewhat poorly drained Lamartine soils, in the same landscape positions, are underlain by loamy glacial till at depths of 20 to 36 inches. The poorly drained Ossian soils, on nearby lowlands, have low chroma matrix color throughout the B horizon. The well drained St. Charles soils, in higher landscape positions, do not have low chroma mottles.

Typical pedon in an area of Atterberry silt loam, 0 to 3 percent slopes, 212 feet south and 343 feet east of northwest corner SW1/4 sec. 32, T. 17 N., R. 15 E.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; very friable; common fine roots; neutral; abrupt smooth boundary.

A2—9 to 13 inches; brown (10YR 5/3) silt loam; moderate thin platy structure; very friable; common fine roots; neutral; clear wavy boundary.

B1t—13 to 18 inches; dark yellowish brown (10YR 4/4) silty clay loam; common fine distinct grayish brown (10YR 5/2) and yellowish red (5YR 4/6) inped mottles; moderate very fine subangular blocky structure; friable; common fine roots; common thin dark brown (10YR 4/3) clay films on faces of peds; few dusky red (2.5YR 3/2) inped concretions; strongly acid; clear wavy boundary.

B21t—18 to 23 inches; brown (10YR 4/3) silty clay loam; many fine faint grayish brown (10YR 5/2), common fine prominent yellowish red (5YR 4/6), and many fine prominent strong brown (7.5YR 5/6) inped and exped mottles; moderate very fine angular and subangular blocky structure; friable; common fine roots; many thin dark grayish brown (10YR 4/2) clay films on faces of peds; few dusky red (2.5YR 3/2) inped concretions; strongly acid; clear wavy boundary.

B22tg—23 to 29 inches; grayish brown (10YR 5/2) silty clay loam; common fine prominent yellowish red (5YR 4/6) and many fine prominent strong brown (7.5YR 5/6) inped and exped mottles; moderate fine angular and subangular blocky structure; friable; common fine roots; many thin dark grayish brown (10YR 4/2) clay films on faces of peds; common dusky red (2.5YR 3/2) inped concretions; medium acid; clear wavy boundary.

B31tg—29 to 42 inches; grayish brown (10YR 5/2) silty clay loam; many fine prominent strong brown (7.5YR 5/6) inped mottles; common fine prominent strong brown (7.5YR 5/6) exped mottles; strong fine and medium prismatic structure; firm; few fine roots; many thin dark grayish brown (10YR 4/2) clay films on faces of prisms; many dusky red (2.5YR 3/2) inped concretions; slightly acid; clear wavy boundary.

B32tg—42 to 52 inches; grayish brown (2.5Y 5/2) silt loam; many fine prominent yellowish brown (10YR 5/6) inped mottles; few fine prominent strong brown (7.5YR 5/6) exped mottles; moderate coarse prismatic structure; friable; few fine roots; common thin and moderately thick dark gray (10YR 4/1) clay films on faces of prisms; many dusky red (2.5YR 3/2) inped concretions; neutral; gradual wavy boundary.

C—52 to 60 inches; grayish brown (2.5Y 5/2) silt loam; many fine prominent yellowish brown (10YR 5/6) mottles; massive; very friable; few fine roots; many dusky red (2.5YR 3/2) concretions; neutral.

Thickness of the solum ranges from 42 to 60 inches.

The Ap horizon has value of 2 or 3 and chroma of 1 or 2. The Ap and A2 horizons are slightly acid or neutral. The A2 horizon has value of 4 through 6 and chroma of 2 or 3. The B1t horizon is silt loam or silty clay loam. The B1t and B2t horizons have value of 4 or 5 and chroma of 2 through 4. They are medium or strongly acid. The B3t horizon has hue of 10YR, 2.5Y or 5Y, and value of 5 or 6. It is slightly acid or neutral.

Borth series

The Borth series consists of moderately well drained soils that are slowly permeable in the upper part and rapidly permeable in the lower part. These soils formed in clayey water-laid sediments over sandy material. They are on low ridges in glacial lake basins. Slopes are 1 to 4 percent.

Borth soils formed in the same kind of material as the nearby Poy and Zittau soils. The Bt horizon of Borth soils is similar to that of Kaukauna and Winneconne soils. The poorly drained Poy and somewhat poorly drained Zittau soils are in lower landscape positions. Kaukauna soils are underlain by loamy material within a depth of 40 inches. Winneconne soils have a clay C horizon.

Typical pedon in an area of Borth silty clay loam, 1 to 4 percent slopes, 40 feet south and 460 feet east of northwest corner sec. 31, T. 20 N., R. 15 E.

Ap—0 to 8 inches; dark brown (7.5YR 3/2) silty clay loam; grayish brown (10YR 5/2) dry; weak medium

subangular blocky structure; firm; common fine roots; neutral; abrupt smooth boundary.

B21t—8 to 15 inches; reddish brown (5YR 4/3) clay; strong fine angular and subangular blocky structure; firm; common fine roots; many thin clay films on faces of peds; common dark brown (7.5YR 3/2) worm casts; neutral; clear wavy boundary.

B22t—15 to 24 inches; reddish brown (5YR 4/3) clay; weak medium prismatic structure parting to moderate medium subangular blocky; firm; common fine roots; many thin clay films on faces of peds; neutral; clear wavy boundary.

B3t—24 to 30 inches; reddish brown (5YR 5/3) clay; few fine prominent yellowish red (5YR 4/6) mottles; strong fine prismatic structure; firm; common fine roots; common moderately thick dark reddish brown (5YR 3/4) clay films on faces of peds; many fine and medium pink (5YR 7/3) lime segregations disseminated throughout the mass; strong effervescence; mildly alkaline; abrupt wavy boundary.

IIC1—30 to 55 inches; brown (7.5YR 5/4) fine and medium sand; common medium prominent strong brown (7.5YR 5/8) and few medium faint pale brown (10YR 6/3) mottles; single grained; loose; mildly alkaline; clear wavy boundary.

IIC2—55 to 60 inches; pale brown (10YR 6/3) fine and medium sand; single grained; loose; mildly alkaline.

Thickness of the solum and depth to the underlying sandy material range from 20 to 40 inches. Carbonates are in the B3t horizon or just below the solum. The solum ranges from medium acid to moderately alkaline.

The Ap horizon has 7.5YR or 10YR hue, value of 2 or 3, and chroma of 1 or 2. It commonly is silty clay loam, but in some pedons it is silt loam or silty clay. The Bt horizon commonly is clay, but subhorizons of silty clay are in some pedons. The IIC horizon is neutral or mildly alkaline.

Brems series

The Brems series consists of moderately well drained, rapidly permeable soils formed in thick deposits of sand. These soils are on stream and lake terraces and on low sand ridges in glacial lake basins. Slopes are 1 to 4 percent. The Brems soils in this survey area are outside the range defined for the series because they lack mottles with chroma of 2. This difference, however, does not alter the use or behavior of the soils.

Brems soils are similar to nearby Morocco and Oakville soils. Morocco soils, in slightly lower landscape positions, are somewhat poorly drained. Oakville soils, in higher landscape positions, are well drained.

Typical pedon in an area of Brems fine sand, 1 to 4 percent slopes, 260 feet south and 1,820 feet west of northeast corner sec. 7, T. 20 N., R. 14 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) fine sand; weak fine subangular blocky structure; very friable; many fine roots; neutral; abrupt smooth boundary.

B2—8 to 25 inches; yellowish brown (10YR 5/4) fine sand; weak medium subangular blocky structure; very friable; few fine roots; medium acid; clear wavy boundary.

B31—25 to 30 inches; yellowish brown (10YR 5/6) fine sand; common medium distinct strong brown (7.5YR 5/8) and prominent brown (10YR 5/3) mottles; single grained; loose; few fine roots; medium acid; clear wavy boundary.

B32—30 to 41 inches; strong brown (7.5YR 5/6) fine sand; common fine distinct yellowish red (5YR 4/8), many coarse distinct strong brown (7.5YR 5/8), and many medium prominent pale brown (10YR 6/3) mottles; single grained; loose; medium acid; gradual wavy boundary.

C—41 to 60 inches; pale brown (10YR 6/3) fine sand; common medium prominent brownish yellow (10YR 6/8) mottles in upper part; single grained; loose; saturated with water; medium acid.

Thickness of the solum ranges from 35 to 50 inches.

The Ap horizon has value of 3 or 4. It ranges from medium acid to neutral. Some pedons have an A1 horizon less than 5 inches thick. The B horizon averages between 50 and 70 percent fine sand and between 20 and 40 percent medium sand. It ranges from medium to very strongly acid. Some pedons have a Bir horizon. The C horizon is medium or fine sand. Unweathered loamy or clayey layers are at depths of 45 to 60 inches in some pedons.

Casco series

The Casco series consists of well drained soils that are moderately permeable in the upper part and very rapidly permeable in the lower part. These soils formed in a loamy mantle over gravel and sand outwash deposits (fig. 6). They are on valley slopes, knolls, and ridges in the uplands. Slopes are 2 to 15 percent.

Casco soils have the same kind of IIC horizon as Fox and Lorenzo Variant soils and commonly are near Fox soils. All are in similar landscape positions. Fox soils have a solum 24 to 40 inches thick. Lorenzo Variant soils have a IIIC horizon of loamy or clayey glacial till at depths of 24 to 40 inches.

Typical pedon in an area of Casco loam, 6 to 15 percent slopes, eroded, 960 feet east and 390 feet north of southwest corner sec. 28, T. 17 N., R. 14 E.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) loam; weak medium subangular blocky structure; friable; common fine roots; about 30 percent by volume of dark yellowish brown (10YR 4/4) loam subsoil material incorporated by tillage; about 5 percent by volume of gravel; neutral; abrupt smooth boundary.

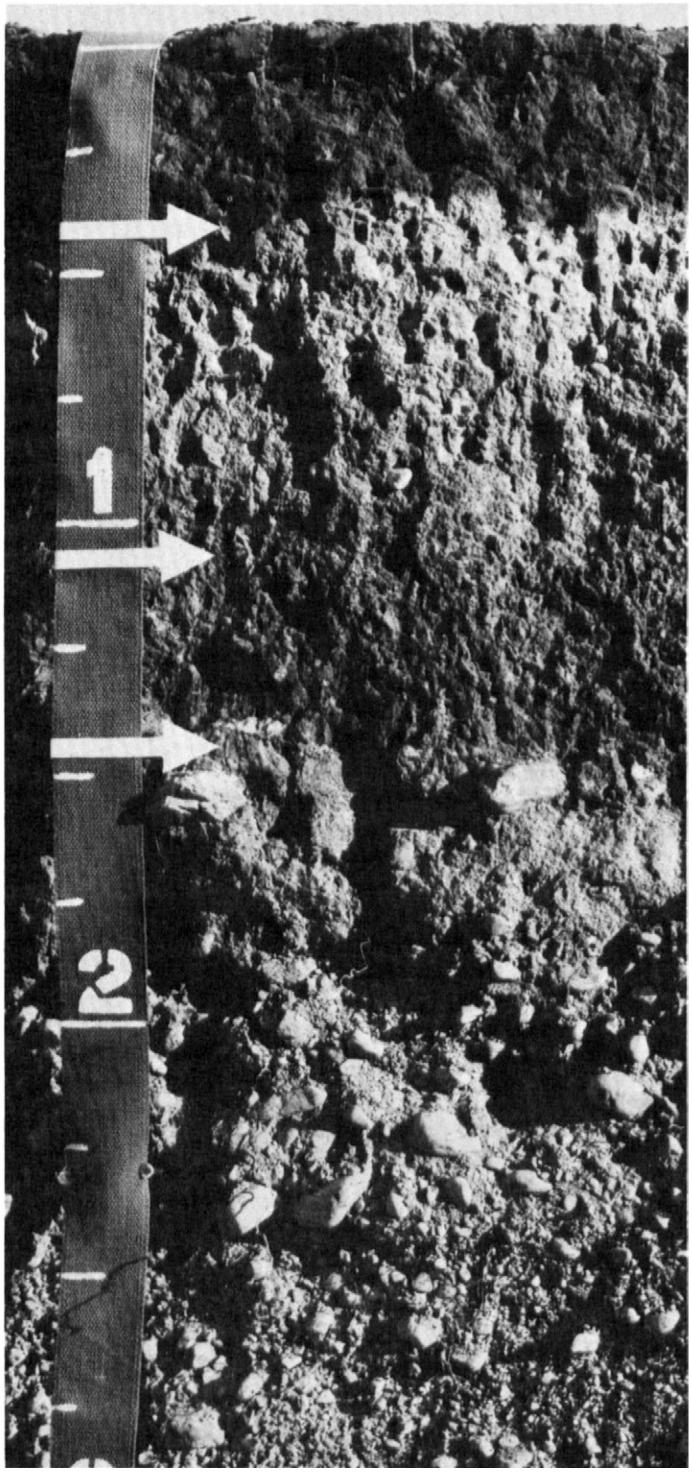


Figure 6.—Profile of Casco loam. The substratum is a good source of sand and gravel. The scale is in feet.

B21t—7 to 12 inches; dark brown (7.5YR 4/4) loam; moderate fine subangular blocky structure; friable; few fine roots; many thin clay films on faces of peds; about 10 percent by volume of gravel; few dark grayish brown (10YR 4/2) worm casts; neutral; clear wavy boundary.

B22t—12 to 15 inches; dark brown (7.5YR 4/4) clay loam; moderate medium subangular blocky structure; friable; few fine roots; many thin clay films on faces of peds; about 10 percent by volume of gravel; neutral; abrupt wavy boundary.

B3t—15 to 17 inches; dark brown (7.5YR 3/2) gravelly sandy loam; weak coarse subangular blocky structure; very friable; few fine roots; many thin clay bridges between mineral grains; about 25 percent by volume of gravel; mildly alkaline; abrupt wavy boundary.

IIC—17 to 60 inches; yellowish brown (10YR 5/4) gravel and sand; stratified; single grained; loose; about 55 percent by volume of gravel and cobblestones; strong effervescence; moderately alkaline.

Thickness of the solum ranges from 10 to 24 inches, the same as the depth to the gravel and sand IIC horizon. Reaction in the solum ranges from slightly acid to mildly alkaline.

The Ap and B2t horizons are up to 15 percent by volume gravel. The B2t horizon has hue of 10YR, 7.5YR, or 5YR and value and chroma of 3 or 4. The B3t horizon is sandy loam or sandy clay loam that is 10 to 25 percent by volume gravel. The IIC horizon is mildly or moderately alkaline. It is 30 to 60 percent by volume gravel.

Edwards series

The Edwards series consists of very poorly drained, moderately rapidly permeable soils formed in deposits of organic material over marl. These soils are in the outer fringes of depressional areas and in low areas adjacent to lakes. Slopes are 0 to 2 percent.

Edwards soils are similar to Adrian, Houghton, Palms, and Willette soils. All formed in deposits of organic material. Adrian soils are underlain by sandy material at depths of 16 to 51 inches. Houghton soils have organic material extending to depths greater than 51 inches. Palms soils have loamy material at depths of 16 to 51 inches that averages less than 35 percent clay. Willette soils have clayey or loamy material at depths of 16 to 51 inches that averages more than 35 percent clay.

Typical pedon in an area of Edwards muck, 130 feet west and 340 feet south of the northeast corner sec. 35, T. 17 N., R. 14 E.

Oa1—0 to 8 inches; black (N 2/0, broken face and rubbed), black (5YR 2/1, pressed) sapric material; about 12 percent fiber, less than 5 percent rubbed; massive; very friable; primarily herbaceous fibers; sodium pyrophosphate very dark grayish brown (10YR 3/2); neutral; abrupt smooth boundary.

Oa2—8 to 18 inches; black (N 2/0, broken face and rubbed), dark reddish brown (5YR 2/2, pressed)

sapric material; about 3 percent fiber, a trace rubbed; weak medium subangular blocky structure; friable; primarily herbaceous fibers; sodium pyrophosphate very dark brown (10YR 2/2); neutral; abrupt smooth boundary.

Oa3—18 to 23 inches; dark reddish brown (5YR 2/2, broken face), black (10YR 2/1, rubbed and pressed) sapric material; about 8 percent fiber, less than 2 percent rubbed; weak thick platy structure; friable; primarily herbaceous fibers; sodium pyrophosphate brown (10YR 5/3); few woody fragments; neutral; abrupt smooth boundary.

Lca—23 to 60 inches; gray (5Y 5/1) marl; massive; very friable; few woody fragments; violent effervescence; mildly alkaline.

The depth to the marl (Lca horizon) ranges from 16 to 51 inches. The organic material is primarily herbaceous, but some pedons are as much as 10 percent by volume woody fragments. The organic material ranges from medium acid to mildly alkaline.

The surface tier commonly has 10YR hue or is neutral and has chroma of 0 through 2 on broken face and rubbed. The organic part of the subsurface and bottom tiers has 10YR, 7.5YR, 5YR or N hue, value of 2 or 3, and chroma of 0 through 2. Some pedons contain thin layers of hemic material in these tiers. Snail shells are in the organic layers of some pedons. The Lca horizon is mildly or moderately alkaline.

Eleva series

The Eleva series consists of well drained, moderately or moderately rapidly permeable soils formed in loamy glacial material and the residuum from sandstone. These soils are on valley sides. Slopes are 8 to 20 percent.

Eleva soils are similar to Knowles and Whalan soils. Knowles and Whalan soils are in similar landscape positions, but they are more than 18 percent clay in the argillic horizon and are 20 to 40 inches deep over limestone bedrock.

Typical pedon in an area of Eleva loam, 8 to 20 percent slopes, eroded, 400 feet south and 1,250 feet west of northeast corner SW1/4 sec. 32, T. 17 N., R. 14 E.

Ap—0 to 5 inches; dark brown (10YR 4/3) loam; weak fine subangular blocky structure; friable; many fine roots; trace of fine gravel; slightly acid; abrupt smooth boundary.

B2t—5 to 10 inches; brown (7.5YR 4/4) loam; weak fine and medium subangular blocky structure; friable; many fine roots; common thin clay films on faces of peds; trace of fine gravel; slightly acid; abrupt smooth boundary.

IIB3—10 to 21 inches; strong brown (7.5YR 5/6) fine sand; very weak coarse subangular blocky structure; very friable; few fine roots; few thin clay bridges between mineral grains; slightly acid; clear wavy boundary.

Cr—21 to 41 inches; yellow (10YR 7/6) weakly cemented sandstone bedrock; neutral.

R—41 inches; light yellowish brown (10YR 6/4) strongly cemented sandstone bedrock.

Thickness of the solum ranges from 20 to 30 inches. Depth to strongly cemented sandstone ranges from 40 to 60 inches. Reaction in the solum is medium or slightly acid. The solum is less than 2 percent by volume gravel.

The Ap horizon has value of 4 or 5 and chroma of 2 or 3. The B2t horizon is loam or fine sandy loam. The IIB3 horizon is fine sand, loamy fine sand, or fine sandy loam. The Cr horizon is weakly cemented sandstone or fine sand that contains fragments of sandstone.

Fisk series

The Fisk series consists of somewhat poorly drained soils that are rapidly permeable in the upper part and moderately permeable in the lower part. These soils formed in sandy deposits and the underlying loamy and silty water-laid sediments. They are in glacial lake basins, on beaches, and on terraces of streams, lakes, and valleys. Slopes are 0 to 3 percent.

Fisk soils are similar to Yahara soils in having a stratified C horizon. They have the same kind of B horizon, in the upper sandy material, as that of Morocco and Nebago soils. The somewhat poorly drained Yahara soils lack the upper sandy deposits and are coarse loamy. The somewhat poorly drained Morocco soils are sandy to depths of 40 inches or more. The somewhat poorly drained Nebago soils are sandy over clayey.

Typical pedon in an area of Fisk loamy fine sand, 0 to 3 percent slopes, 1,245 feet east and 70 feet south of northwest corner sec. 6, T. 20 N., R. 14 E.

Ap—0 to 9 inches; very dark brown (10YR 2/2) loamy fine sand; weak fine subangular blocky structure; very friable; common fine roots; neutral; abrupt smooth boundary.

B1—9 to 24 inches; brown (10YR 4/3) fine sand; many coarse faint grayish brown (10YR 5/2) mottles, common fine prominent red (2.5YR 4/6) mottles, and common medium prominent strong brown (7.5YR 5/6) mottles; single grained; loose; common fine roots; common very dark brown (10YR 2/2) worm casts in upper 3 inches; large pockets or discontinuous layers of grayish brown (10YR 5/2) fine sand in lower 10 inches; medium acid; abrupt smooth boundary.

IIB21—24 to 27 inches; light olive brown (2.5Y 5/4) fine sandy loam; many medium distinct grayish brown (10YR 5/2) mottles and common fine prominent strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; very friable; common fine roots; slightly acid; abrupt smooth boundary.

IIB22g—27 to 31 inches; grayish brown (10YR 5/2) silt loam; many medium prominent strong brown (7.5YR

5/6) mottles; moderate coarse prismatic structure parting to weak subangular blocky; friable; few fine roots; slightly acid; clear wavy boundary.

IIB3g—31 to 39 inches, grayish brown (2.5YR 5/2) silt loam; many medium prominent strong brown (7.5YR 5/6) mottles and common fine distinct reddish brown (5YR 5/3) mottles; moderate coarse prismatic structure parting to moderate thin platy; friable; few fine roots; slightly acid; clear wavy boundary.

IIC—39 to 60 inches; brown (7.5YR 5/4) silt loam and pinkish gray (7.5YR 6/2) very fine sandy loam, stratified; common fine distinct pinkish gray (7.5YR 6/2) mottles in silt loam and many medium prominent strong brown (7.5YR 5/6) mottles; weak thick platy structure; very friable; few fine roots; slight effervescence below a depth of 55 inches; mildly alkaline.

Thickness of the solum ranges from 30 to 50 inches. The sandy material is 20 to 40 inches thick. It is strongly acid to neutral. Free carbonates are below a depth of 40 inches.

The Ap horizon has value of 2 through 4 and chroma of 1 through 3. Some pedons have an A1 horizon 2 to 6 inches thick and an A2 horizon 2 to 4 inches thick.

The B1 horizon has 10YR or 7.5YR hue, value of 4 through 6, and chroma of 2 through 4. It is loamy fine sand or fine sand that averages between 20 and 40 percent medium sand and between 50 and 65 percent fine sand.

The IIB and IIC horizons have 7.5YR, 10YR, 2.5Y, or 5Y hue, value of 4 through 6, and chroma of 2 through 4. The IIB horizon ranges from slightly acid to mildly alkaline. The IIB21 horizon is loam or fine sandy loam. The IIB22g and IIB3g horizons commonly are silt loam, loam, or very fine sandy loam. The IIC horizon ranges from neutral to moderately alkaline.

Fox series

The Fox series consists of well drained soils that are moderately permeable in the upper part and rapidly or very rapidly permeable in the lower part. These soils formed in an upper mantle of silty material and loamy outwash over sand and gravel outwash deposits. They are on small outwash plains adjacent to recessional moraines and on valley sides and high valley terraces. Slopes are 2 to 12 percent.

Fox soils are similar to Casco, McHenry, and Whalan soils. They are near Casco soils. Casco soils, in similar landscape positions, formed in similar material but have a solum less than 24 inches thick. McHenry soils are fine-loamy but formed in glacial till and lack sand and gravel outwash deposits within a depth of 40 inches. Whalan soils are fine loamy but have limestone bedrock within a depth of 20 to 40 inches.

Typical pedon in an area of Fox silt loam, 2 to 6 percent slopes, 968 feet south and 20 feet west of northeast corner SE1/4 sec. 29, T. 17 N., R. 14 E.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) silt loam; weak coarse subangular blocky structure; very friable; common fine roots; neutral; abrupt smooth boundary.

A2—9 to 11 inches; brown (10YR 5/3) silt loam; weak thin platy structure; very friable; few fine roots; many dark grayish brown (10YR 4/2) worm casts; neutral; abrupt wavy boundary.

B1t—11 to 14 inches; dark yellowish brown (10YR 4/4) silt loam; weak fine subangular blocky structure; very friable; few fine roots; few thin clay films on faces of peds; slightly acid; clear wavy boundary.

B21t—14 to 19 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate fine subangular blocky structure; friable; few fine roots; common thin clay films on faces of peds; about 3 percent by volume of fine gravel; medium acid; clear wavy boundary.

IIB22t—19 to 23 inches; dark brown (7.5YR 4/4) loam; moderate fine and medium subangular blocky structure; friable; few fine roots; many thin clay films on faces of peds; about 7 percent by volume of gravel; medium acid; abrupt wavy boundary.

IIB3t—23 to 31 inches; dark brown (7.5YR 3/2) sandy clay loam; weak medium subangular blocky structure; friable; few fine roots; many moderately thick clay films on faces of peds; about 10 percent by volume of gravel; slightly acid; abrupt wavy boundary.

IIIC—31 to 60 inches; yellowish brown (10YR 5/4) sand and gravel; single grained; loose; about 21 percent by volume of gravel; strong effervescence; mildly alkaline.

Thickness of the solum ranges from 24 to 40 inches, the same as the depth to free carbonates. Thickness of the upper silty material is less than 24 inches. Reaction in the solum ranges from medium acid to neutràl. The solum is up to 15 percent by volume coarse fragments.

The Ap horizon has value of 3 or 4. Some pedons lack an A2 horizon. The IIB2t horizon is loam or clay loam. The IIB3t horizon is sandy loam or sandy clay loam. The IIC horizon is mildly or moderately alkaline. It is 20 to 60 percent by volume gravel.

Grellton series

The Grellton series consists of well drained, moderately permeable soils formed in three layers of parent material. The upper layer is loamy material. The middle layer is silty material. The lower layer is loamy glacial till. These soils are on valley sides and broad moraines of till plains. Slopes are 2 to 6 percent.

Grellton soils are near McHenry and Plano soils. They are similar to Puchyan soils. McHenry and Plano soils are in similar landscape positions but have a silty A horizon. They are also silty in the upper part of the B horizon. McHenry soils have a thinner solum and more sand in the lower part of the B2 horizon. Plano soils

have a mollic epipedon and are fine-silty. Puchyan soils have similar material in the lower part of the solum, but the upper layer is sandy material. Consequently, the control section is coarse loamy.

Typical pedon in an area of Grellton fine sandy loam, 2 to 6 percent slopes, 320 feet east and 40 feet south of northwest corner SE1/4NW1/4 sec. 31, T. 17 N., R. 14 E.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) fine sandy loam; weak fine subangular blocky structure; very friable; many fine roots; slightly acid; abrupt smooth boundary.

A2—8 to 13 inches; brown (10YR 5/3) fine sandy loam; weak thin platy structure; very friable; many fine roots; medium acid; clear wavy boundary.

B21t—13 to 24 inches; dark yellowish brown (10YR 4/4) loam; moderate very fine subangular blocky structure; friable; common fine roots; common thin clay films on faces of peds; strongly acid; clear wavy boundary.

IIB22t—24 to 31 inches; dark yellowish brown (10YR 4/4) silt loam; moderate fine subangular blocky structure; friable; common fine roots; many thin dark brown (7.5YR 4/4) clay films on faces of peds; strongly acid; clear wavy boundary.

IIB23t—31 to 40 inches; dark brown (10YR 4/3) silt loam; moderate medium subangular blocky structure; friable; few fine roots; many thin dark brown (7.5YR 4/4) clay films on faces of peds; strongly acid; abrupt wavy boundary.

IIIB31t—40 to 45 inches; dark brown (10YR 4/3) loam; weak medium subangular blocky structure; friable; few fine roots; few thin clay films on faces of peds; about 5 percent by volume of fine gravel; medium acid; clear wavy boundary.

IIIB32t—45 to 57 inches; dark brown (7.5YR 4/4) sandy loam; weak medium subangular blocky structure; very friable; few fine roots; continuous thin clay bridges between mineral grains; about 5 percent by volume of gravel; slightly acid; abrupt wavy boundary.

IIIC—57 to 60 inches; yellowish brown (10YR 5/4) sandy loam; massive; very friable; about 8 percent by volume of gravel; slight effervescence; moderately alkaline.

Thickness of the solum ranges from 45 to 60 inches.

The Ap horizon has value of 3 or 4. Some pedons have no A2 horizon. The B2t horizon is loam or fine sandy loam. It is slightly acid to strongly acid. The IIB2t horizon is loam, fine sandy loam, or sandy loam. The IIIC horizon is sandy loam or fine sandy loam. The IIIB and IIIC horizons are 5 to 25 percent by volume gravel.

Hochheim series

The Hochheim series consists of well drained, moderately or moderately slowly permeable soils formed in loamy glacial till. The glacial till has a high content of dolomite fragments. These soils are on broad crests of hills and ridges of till plains. Slopes are 2 to 6 percent.

Hochheim soils are similar to LeRoy and Nenno soils. They are near Nenno and Omro soils. LeRoy soils lack a mollic epipedon and have a calcium carbonate equivalent of 60 to 90 percent in the C horizon. The somewhat poorly drained Nenno soils, in lower landscape positions, are mottled in the B horizon. Omro soils, in similar landscape positions, have a similar C horizon but are finer textured in the B horizon.

Typical pedon in an area of Hochheim loam, 2 to 6 percent slopes, 600 feet east and 50 feet north of southwest corner NW1/4NW1/4 sec. 18, T. 17 N., R. 17 E.

Ap—0 to 7 inches; very dark brown (10YR 2/2) loam, dark grayish brown (10YR 4/2) dry; weak very fine subangular blocky structure; friable; many fine roots; about 8 percent by volume of gravel; mildly alkaline; abrupt smooth boundary.

B2t—7 to 12 inches; dark reddish brown (5YR 3/4) loam; moderate very fine subangular blocky structure; friable; common fine roots; about 10 percent by volume of gravel; many thin clay films on faces of peds; neutral; abrupt wavy boundary.

B3t—12 to 16 inches; reddish brown (5YR 4/4) gravelly loam; weak coarse subangular blocky structure; very friable; common fine roots; few thin clay bridges between mineral grains; about 35 percent by volume of gravel; mildly alkaline; abrupt wavy boundary.

C—16 to 60 inches; light yellowish brown (10YR 6/4) gravelly fine sandy loam; weak thin platy structure; very friable; about 20 percent by volume of gravel; few cobblestones and boulders; strong effervescence; moderately alkaline (calcium carbonate equivalent 46 percent).

Thickness of the solum ranges from 12 to 20 inches. Content of gravel by volume ranges from about 2 to 20 percent in the B2t horizon and from about 20 to 35 percent in the B3t and C horizons.

The Ap horizon has hue of 10YR or 7.5YR and value of 2 or 3. The B horizon has 10YR, 7.5YR, or 5YR hue and value and chroma of 3 or 4. The B2t horizon is clay loam or loam. The B3t horizon is gravelly loam or gravelly fine sandy loam. The C horizon has a calcium carbonate equivalent of 40 to 60 percent. It is mildly or moderately alkaline.

Hortonville series

The Hortonville series consists of well drained, moderately or moderately slowly permeable soils formed in a thin mantle of silty or sandy material and in the underlying loamy glacial till. These soils are on valley sides and moraines on till plains. Slopes are 2 to 12 percent. The Hortonville soils in this survey area are outside the defined limits of the series because they lack the interfin-

gering of an albic horizon into the argillic horizon. This difference, however, does not alter the use or behavior of the soils.

Hortonville soils are similar to Kewaunee, Kidder, and Whalan soils. They are near Kewaunee and Whalan soils. Kewaunee soils, in similar landscape positions, are finer textured. Kidder soils lack 5YR colors in the B and C horizons and have less clay and more sand in the C horizon. Whalan soils, in similar landscape positions, are underlain by limestone bedrock at depths of 20 to 40 inches.

Typical pedon in an area of Hortonville silt loam, 2 to 6 percent slopes, 860 feet west and 660 feet north of southeast corner NE1/4 sec. 16, T. 17 N., R. 16 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam; light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; friable; many fine roots; trace of gravel; neutral; abrupt smooth boundary.

B21t—8 to 18 inches; reddish brown (5YR 4/3) clay loam; moderate very fine subangular blocky structure; friable; common fine roots; many thin clay films on faces of peds; about 3 percent by volume of gravel; neutral; clear wavy boundary.

B22t—18 to 23 inches; reddish brown (5YR 4/3) clay loam; moderate fine subangular blocky structure; friable; common fine roots; common thin clay films on faces of peds; about 4 percent by volume of gravel; neutral; clear wavy boundary.

B3t—23 to 28 inches; reddish brown (5YR 4/4) loam; weak fine subangular blocky structure; friable; common fine roots; few thin clay films on faces of prisms; about 8 percent by volume of gravel; slight effervescence; mildly alkaline; clear wavy boundary.

C—28 to 60 inches; reddish brown (5YR 4/4) loam; massive; friable; about 10 percent by volume of gravel; few stones; strong effervescence; moderately alkaline.

Thickness of the solum ranges from 26 to 40 inches. Thickness of the upper silty or sandy material is less than 20 inches. Free carbonates are in the B3 horizon or just below the solum. The solum and the C horizon are 2 to 20 percent by volume dolomite gravel.

The Ap horizon has 10YR or 7.5YR hue, value of 3 or 4, and chroma of 2 or 3. It is silt loam or loamy fine sand. It is neutral or slightly acid. Some pedons have an A2 or B1 horizon with texture similar to that of the Ap horizon. Some pedons have coatings of A2 material on faces of peds in the upper part of the Bt horizon. The B2t and B3t horizons commonly are clay loam or loam, but subhorizons of clay are in some pedons. The Bt horizon ranges from medium acid to neutral in the upper part. It is neutral or mildly alkaline in the lower part. The C horizon is loam or clay loam. It is mildly or moderately alkaline.

Houghton series

The Houghton series consists of very poorly drained, moderately rapidly permeable soils formed in deposits of organic material more than 51 inches thick. These soils are in depressional areas and in low areas adjacent to drainageways and lakes. Slopes are 0 to 2 percent.

Houghton soils are similar to Adrian, Edwards, Palms, and Willette soils. All formed in deposits of organic material. Adrian, Palms, and Willette soils have a mineral substratum at depths of 16 to 51 inches. Edwards soils have a marl substratum at depths of 16 to 51 inches.

Typical pedon in an area of Houghton muck, 90 feet west and 400 feet south of northeast corner SE1/4NE1/4 sec. 35, T. 17 N., R. 14 E.

Oa1—0 to 3 inches; very dark brown (10YR 2/2, broken face, rubbed and pressed) sapric material; about 10 percent fiber, less than 5 percent rubbed; weak fine subangular blocky structure; very friable; primarily herbaceous fibers; sodium pyrophosphate brown (10YR 4/3); neutral; abrupt smooth boundary.

Oa2—3 to 12 inches; black (10YR 2/1, broken face and pressed), black (N 2/0, rubbed) sapric material; about 2 percent fiber, less than 2 percent rubbed; weak fine subangular blocky structure; very friable; primarily herbaceous fibers; sodium pyrophosphate brown (10YR 5/3); slightly acid; abrupt smooth boundary.

Oa3—12 to 22 inches; black (N 2/0, broken face, rubbed and pressed) sapric material; about 2 percent fiber, less than 2 percent rubbed; weak coarse subangular blocky structure; friable; primarily herbaceous fibers; sodium pyrophosphate dark brown (10YR 3/3); slightly acid; abrupt smooth boundary.

Oa4—22 to 60 inches; dark brown (7.5YR 3/2, broken face and pressed), black (10YR 2/1, rubbed) sapric material; about 30 percent fiber, less than 5 percent rubbed; weak thick platy structure; friable; primarily herbaceous fibers; sodium pyrophosphate brown (10YR 5/3); medium acid.

The organic material is more than 51 inches thick. It is primarily herbaceous, but some pedons are as much as 10 percent by volume woody fragments. This material ranges from medium acid to mildly alkaline.

The surface tier commonly has 10YR hue or is neutral and has chroma of 0 through 2 on broken face and rubbed. The subsurface and bottom tiers have 10YR, 7.5YR, 5YR or N hue, value of 2 or 3, and chroma of 0 through 2. Some pedons contain thin layers of hemic material in these tiers.

Kaukauna series

The Kaukauna series consists of moderately well drained, slowly or very slowly permeable soils formed in clayey over loamy water-laid sediments. These soils are

on terraces in glacial lake basins. Slopes are 1 to 4 percent.

Kaukauna soils have a Bt horizon similar to that of Borth and Winneconne soils. Borth soils are underlain by sand at a depth of 20 to 40 inches. Winneconne soils have a clay B and C horizon.

Typical pedon in an area of Kaukauna silty clay loam, 1 to 4 percent slopes, 390 feet west and 40 feet north of southeast corner NE1/4SE1/4 sec. 35, T. 18 N., R. 16 E.

Ap—0 to 9 inches; very dark brown (10YR 2/2) silty clay loam, dark grayish brown (10YR 4/2) dry; weak fine subangular blocky structure; friable; many fine roots; slightly acid; abrupt smooth boundary.

A2—9 to 12 inches; brown (7.5YR 4/2) silty clay; weak thin platy structure; friable; many fine roots; medium acid; abrupt wavy boundary.

B21t—12 to 18 inches; reddish brown (5YR 4/3) clay; moderate very fine angular and subangular blocky structure; firm; many fine roots; many thin clay films on faces of peds; medium acid; clear wavy boundary.

B22t—18 to 26 inches; reddish brown (5YR 4/3) clay; weak fine prismatic structure parting to moderate fine angular blocky; firm; common fine roots; many thin clay films on faces of peds; slightly acid; gradual wavy boundary.

B31t—26 to 37 inches; reddish brown (5YR 4/3) silty clay; moderate medium prismatic structure; firm; common fine roots; many thin clay films on faces of peds; slight effervescence; mildly alkaline; abrupt wavy boundary.

IIB32t—37 to 44 inches; dark brown (10YR 4/3) silt loam; common fine prominent strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; few fine roots; common thin reddish brown (5YR 4/3) clay films on faces of peds; slight effervescence; mildly alkaline; abrupt smooth boundary.

IIB33t—44 to 48 inches; dark brown (7.5YR 4/4) loam; many fine distinct strong brown (7.5YR 5/6) mottles; weak coarse subangular blocky structure; friable; few fine roots; few thin reddish brown (5YR 4/3) clay films in interstitial pores; slight effervescence; mildly alkaline; clear wavy boundary.

IIC—48 to 60 inches; dark yellowish brown (10YR 4/4) and brown (10YR 5/3) very fine sand and silt; stratified; common medium distinct and prominent yellowish brown (10YR 5/6) mottles and many coarse faint and distinct grayish brown (10YR 5/2) mottles; weak thin platy structure; very friable; slight effervescence; mildly alkaline.

Thickness of the solum ranges from 30 to 50 inches. Thickness of the upper clayey material and depth to carbonates range from 20 to 40 inches. The solum is medium acid to mildly alkaline in the upper part and neutral to moderately alkaline in the lower part.

The Ap horizon has 7.5YR or 10YR hue, value of 2 or 3, and chroma of 1 or 2. Some pedons lack an A2 horizon. The IIB3 horizon has 7.5YR or 10YR hue, value of 4 through 6, and chroma of 3 or 4. It is silt loam, loam, or very fine sandy loam. Some pedons lack a IIB3 horizon. The IIC horizon has strata of silt, fine sand, or very fine sand. It is mildly or moderately alkaline.

Keowns series

The Keowns series consists of poorly drained, moderately permeable soils formed in silty and sandy water-laid sediments. These soils are in depressional areas and upland drainageways. Slopes are 0 to 2 percent.

Keowns soils formed in the same kind of material as Korobago, Wauseon, and Yahara soils. The somewhat poorly drained Korobago soils and the poorly drained Wauseon soils have at depths of 20 to 40 inches glacial deposits that are more than 35 percent clay. The somewhat poorly drained Yahara soils do not have horizons dominated by chroma of 2 or less in the upper part of the B horizon.

Typical pedon in an area of Keowns silt loam, 880 feet south and 80 feet east of northwest corner NE1/4 sec. 24, T. 17 N., R. 15 E.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, dark grayish brown (10YR 4/2) dry; weak fine granular structure; friable; many fine roots; neutral; abrupt smooth boundary.

B21g—8 to 14 inches; olive gray (5Y 5/2) silt loam; common fine prominent yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; many fine roots; neutral; clear wavy boundary.

B22g—14 to 20 inches; olive gray (5Y 5/2) silt loam; common fine prominent yellowish brown (10YR 5/6) mottles; moderate medium subangular blocky structure; friable; common fine roots; slight effervescence; mildly alkaline; clear wavy boundary.

B23g—20 to 25 inches; olive gray (5Y 5/2) silt loam; common fine prominent yellowish brown (10YR 5/6) and many fine prominent brown (7.5YR 5/4) mottles; weak medium subangular blocky structure; friable; few fine roots; slight effervescence; mildly alkaline; clear wavy boundary.

C—25 to 60 inches; brown (10YR 5/3) fine sand and yellowish brown (10YR 5/4) silt loam; stratified; common fine faint brown (7.5YR 5/4) and few medium distinct and prominent grayish brown (2.5Y 5/2) and yellowish brown (10YR 5/6) mottles; very friable; few thin strata of very fine sand; strong effervescence; mildly alkaline.

Thickness of the solum ranges from 20 to 30 inches. The solum is neutral or mildly alkaline. Free carbonates are at depths of 12 to 24 inches.

The A1 or Ap horizon has 10YR or N hue, value of 2 or 3, and chroma of 0 through 2. Some pedons have a

thin A12 horizon. Some pedons have a dark gray (10YR 4/1) A3 horizon less than 4 inches thick. The B2g horizon has 5Y or 2.5Y hue and value of 5 or 6. It is silt loam, loam, very fine sandy loam, loamy very fine sand, or very fine sand. The C horizon is mildly or moderately alkaline. It contains strata of silt, very fine sand, or fine sand.

Kewaunee series

The Kewuanee series consists of well drained and moderately well drained soils that are moderately slowly or slowly permeable. These soils formed in a thin mantle of silty or sandy material and in the underlying loamy or clayey glacial till (fig. 7). These soils are on ground, end, and recessional moraines. Slopes are 2 to 12 percent.

Kewaunee soils are near Hortonville, Manawa, and Omro soils. They are similar to those soils and Winneconne soils. Hortonville and Omro soils are in similar landscape positions. Hortonville soils formed in similar material but are fine-loamy. Omro soils have a similar Bt horizon, but contain more sand and gravel and less clay in the C horizon within depths of 24 to 40 inches. Manawa soils formed in similar material but have mottles with chroma of 2 or less within the upper 10 inches of the argillic horizon. Winneconne soils have more clay in the solum and formed in lacustrine sediment.

Typical pedon in an area of Kewaunee silt loam, 2 to 6 percent slopes, 2,540 feet north and 200 feet east of southwest corner sec. 36, T. 19 N., R. 14 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam; light brownish gray (10YR 6/2) dry; weak medium subangular blocky structure; very friable; many fine roots; high content of very fine sand; neutral; abrupt smooth boundary.

A2—8 to 10 inches; brown (10YR 5/3) silt loam; weak thin platy structure; very friable; common fine roots; high content of very fine sand; slightly acid; abrupt wavy boundary.

B1t—10 to 13 inches; dark brown (7.5YR 4/4) silty clay loam; moderate fine and very fine subangular blocky structure; friable; common fine roots; few thin clay films on faces of peds; slightly acid; clear wavy boundary.

IIB21t—13 to 18 inches; reddish brown (5YR 4/3) clay; strong fine and very fine angular blocky structure; firm; common fine roots; many thin clay films on faces of peds; few black (5YR 2/1) stains on faces of peds; slightly acid; clear wavy boundary.

IIB22t—18 to 24 inches; reddish brown (5YR 4/3) clay; moderate fine prismatic structure parting to strong fine angular blocky; firm; common fine roots; many thin clay films on faces of peds; about 5 percent by volume of gravel; few black (5YR 2/1) stains on faces of peds; slightly acid; clear wavy boundary.

IIB3t—24 to 29 inches; reddish brown (5YR 4/4) clay; strong medium prismatic structure parting to moderate medium angular blocky; firm; few fine roots; common thin clay films on faces of prisms; about 8 percent by volume of dolomite gravel; slight effervescence; mildly alkaline; clear wavy boundary.

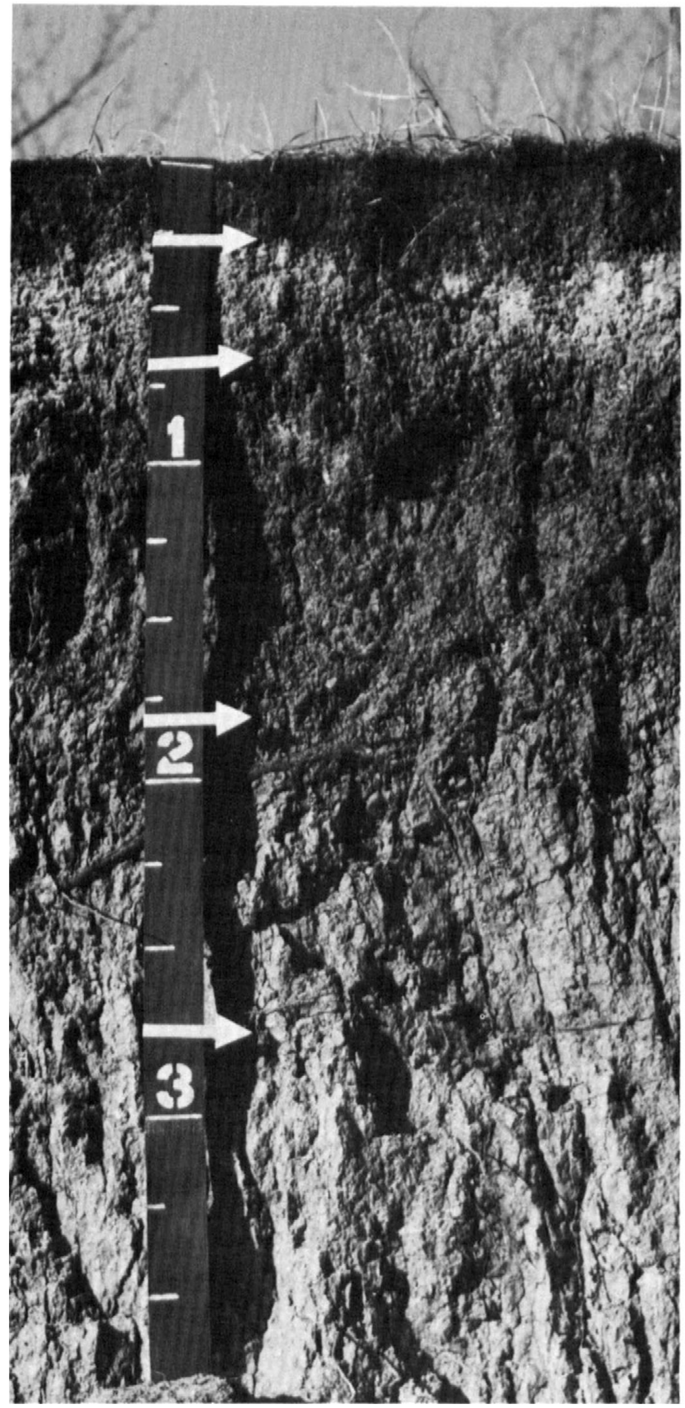


Figure 7.—Profile of Kewaunee silt loam showing prismatic structure in lower part of subsoil. The scale is in feet.

IIC—29 to 60 inches; reddish brown (5YR 4/4) silty clay loam; massive; firm; about 6 percent by volume of gravel; strong effervescence; moderately alkaline.

Thickness of the solum ranges from 26 to 40 inches. Thickness of the upper silty or sandy material is less than 18 inches. Reaction in the solum ranges from medium acid to neutral in the upper part and slightly acid to mildly alkaline in the lower part. Free carbonates are just below the solum or in the B3 horizon. Some pedons are mottled between depths of 3 and 6 feet because they are seasonally saturated. The solum is 0 to 10 percent by volume dolomite gravel.

The Ap horizon has hue of 10YR or 7.5YR and value of 3 or 4. It commonly is silt loam, silty clay loam, or loamy fine sand. Some pedons lack an A2 and B1 horizon. The B2t and B3t horizons commonly are silty clay or clay, but the range includes subhorizons of clay loam and silty clay loam. The C horizon is silty clay, clay, clay loam, or silty clay loam. It is mildly or moderately alkaline.

Kidder series

The Kidder series consists of well drained, moderately permeable soils formed in a thin mantle of silty or sandy material and in the underlying loamy glacial till. These soils are on valley sides, hillsides, and morainic ridges of till plains. Slopes are 2 to 15 percent.

Kidder soils are similar to Fox, McHenry, and Whalan soils. They are commonly near McHenry soils. Fox soils have a similar Bt horizon but are underlain by sand and gravel at depths of 24 to 40 inches. McHenry soils, in similar landscape positions, formed in similar material, but the silty mantle is thicker. Consequently, McHenry soils have a lower content of sand in the upper part of the solum. Whalan soils formed in similar material but overlie limestone bedrock at depths of 20 to 40 inches.

Typical pedon in an area of Kidder silt loam, 6 to 15 percent slopes, eroded, 490 feet west and 60 feet south of northeast corner sec. 16, T. 17 N., R. 14 E.

Ap—0 to 7 inches; very dark grayish brown (10YR 3/2) silt loam; light brownish gray (10YR 6/2) dry; weak medium subangular blocky structure; very friable; common fine roots; neutral; abrupt smooth boundary.

B1—7 to 9 inches; brown (10YR 4/3) silt loam; weak medium subangular blocky structure; very friable; common fine roots; common very dark grayish brown (10YR 3/2) worm casts; neutral; abrupt wavy boundary.

IIB21t—9 to 13 inches; dark brown (7.5YR 4/4) loam; moderate very fine subangular blocky structure; friable; common fine roots; common thin clay films on faces of peds; about 5 percent by volume of gravel; neutral; clear wavy boundary.

IIB22t—13 to 24 inches; dark brown (7.5YR 4/4) sandy clay loam; moderate fine subangular blocky structure; friable; few fine roots; continuous thin clay films on faces of peds; about 8 percent by volume of gravel; neutral; clear wavy boundary.

IIB3t—24 to 32 inches; dark brown (7.5YR 4/4) sandy loam; weak medium subangular blocky structure; friable; few fine roots; common thin clay films on faces of peds; about 8 percent by volume of gravel; neutral; abrupt wavy boundary.

IIC—32 to 60 inches; yellowish brown (10YR 5/4) fine sandy loam; weak thin platy structure; very friable; few fine roots in the upper part; about 10 percent by volume of gravel; slight effervescence; mildly alkaline.

Thickness of the solum ranges from 24 to 40 inches. Thickness of the upper silty or sandy material is less than 15 inches. The solum typically ranges from medium acid to neutral, but the lower part of some pedons is mildly alkaline. The lower part of the solum is up to 15 percent by volume gravel.

The Ap horizon has color value of 3 or 4 and chroma of 2 or 3. The Ap and B1 horizons are mostly silt loam, but in some pedons they are loamy fine sand. The IIB2t horizon is loam, sandy clay loam, or clay loam. The IIC horizon is sandy loam or fine sandy loam. It is 5 to 35 percent by volume gravel.

Kingsville series

The Kingsville series consists of very poorly drained, rapidly permeable soils formed in thick deposits of sand. These soils are in depressional areas of outwash plains and glacial lake basins. Slopes are 0 to 2 percent.

Kingsville soils are near Morocco and Nebago Variant soils. The somewhat poorly drained Morocco soils do not have low chroma matrix colors in the upper part of the B horizon. The very poorly drained Nebago Variant soils have clayey material at depths of 20 to 40 inches.

Typical pedon in an area of Kingsville mucky loamy fine sand, 1,150 feet west and 80 feet north of southeast corner SW1/4 sec. 5, T. 20 N., R. 14 E.

A1—0 to 7 inches; black (10YR 2/1) mucky loamy fine sand, dark gray (10YR 4/1) dry; weak fine granular structure; very friable; many fine roots; strongly acid; abrupt smooth boundary.

B2g—7 to 12 inches; dark gray (10YR 4/1) fine sand; many fine faint grayish brown (10YR 5/2) mottles; weak coarse subangular blocky structure; very friable; common fine roots; discontinuous thin lenses of black (10YR 2/1) mucky fine sand; strongly acid; abrupt irregular boundary.

B3—12 to 26 inches; grayish brown (10YR 5/2) fine sand; many coarse faint dark gray (10YR 4/1) mottles; single grained; loose; few fine roots; medium acid; clear wavy boundary.

C—26 to 60 inches; brown (10YR 5/3) fine sand; single grained; loose; slightly acid.

Thickness of the solum ranges from 18 to 28 inches. The solum commonly is strongly or very strongly acid, but in some pedons it is medium acid.

The A1 horizon is 3 to 9 inches thick. The B2g horizon has value of 4 or 5. The B3 horizon has value of 4 through 6. The C horizon is medium or fine sand. It is medium or slightly acid.

Knowles series

The Knowles series consists of well drained, moderately permeable soils formed in silty material and the underlying loamy glacial till over limestone bedrock. These soils are on valley sides and on ground moraines of till plains. Slopes are 2 to 12 percent.

Knowles soils are near McHenry, Ritchey, and St. Charles soils. They are similar to Whalan soils. McHenry and St. Charles soils are underlain by glacial till and do not have limestone bedrock within a depth of 60 inches. McHenry soils are fine-loamy. Whalan soils, in similar landscape positions, are underlain by limestone and are fine-loamy. Ritchey soils are less than 20 inches deep over limestone.

Typical pedon in an area of Knowles silt loam, 6 to 12 percent slopes, eroded, 925 feet west and 395 feet south of northeast corner SW1/4 sec. 21, T. 17 N., R. 14 E.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam; weak very fine subangular blocky structure; very friable; common fine roots; neutral; abrupt smooth boundary.

B1—6 to 9 inches; brown (10YR 4/3) silt loam; weak fine subangular blocky structure; friable; common fine roots; common dark grayish brown (10YR 4/2) worm casts; slightly acid; clear wavy boundary.

B21t—9 to 17 inches; dark brown (10YR 4/3) silt loam; moderate fine subangular blocky structure; friable; common fine roots; common thin clay films on faces of peds; medium acid; clear wavy boundary.

B22t—17 to 27 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate medium subangular blocky structure; friable; few fine roots; continuous thin clay films on faces of peds; slightly acid; clear wavy boundary.

IIB23t—27 to 32 inches; dark brown (7.5YR 4/4) clay loam; moderate medium subangular blocky structure; friable; few fine roots; many thin dark reddish brown (5YR 3/4) clay films on faces of peds; about 8 percent by volume of gravel; neutral; abrupt wavy boundary.

R—32 inches; bedded limestone bedrock.

Thickness of the solum typically is 30 to 40 inches but ranges from 20 to 40 inches, the same as the depth to bedrock. Thickness of the upper silty material ranges from 20 to 36 inches.

Reaction in the upper silty material of the B horizon ranges from slightly to strongly acid. The IIB horizon is clay loam or sandy clay loam and is up to 15 percent by volume gravel. It ranges from slightly acid to mildly alkaline.

Korobago series

The Korobago series consists of somewhat poorly drained soils that are moderately permeable in the upper part and slowly or moderately slowly permeable in the lower part. These soils formed in silty and loamy water-laid sediment and in the underlying glacial till. They are in swales and drainageways in the uplands. Slopes are 0 to 3 percent.

Korobago soils formed in material similar to that in which Wauseon and Yahara soils formed. The poorly drained Wauseon soils have a B horizon dominated by chroma of 2 or less. The somewhat poorly drained Yahara soils are underlain by stratified very fine sand and very fine sandy loam.

Typical pedon in an area of Korobago silt loam, 0 to 3 percent slopes, 210 feet south and 1,110 feet east of northwest corner NE1/4 sec. 36, T. 19 N., R. 16 E.

Ap—0 to 9 inches; black (10YR 2/1) silt loam; weak fine subangular blocky structure; friable; many fine roots; mildly alkaline; abrupt smooth boundary.

B21—9 to 19 inches; dark yellowish brown (10YR 4/4) silt loam; common medium distinct grayish brown (10YR 5/2) and yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; friable; common fine roots; common worm casts; discontinuous lenses of olive gray (5Y 5/2) silt loam in lower 2 inches; mildly alkaline; abrupt smooth boundary.

B22—19 to 26 inches; brown (7.5YR 4/4) loamy very fine sand; many medium distinct grayish brown (10YR 5/2) and prominent strong brown (7.5YR 5/6) mottles; weak coarse subangular blocky structure; very friable; few fine roots; few worm casts; few thin strata of very fine sand and very fine sandy loam; neutral; abrupt smooth boundary.

B23—26 to 31 inches; brown (7.5YR 5/4) loam; many medium faint grayish brown (10YR 5/2) and prominent strong brown (7.5YR 5/6) mottles; weak medium prismatic structure; friable; few fine roots; few worm casts; about 3 percent by volume of very coarse sand and fine gravel; few thin strata of very fine sand; slight effervescence; mildly alkaline; abrupt smooth boundary.

IIB24—31 to 36 inches; reddish brown (5YR 4/3) silty clay loam; many fine faint brown (7.5YR 4/4 and 7.5YR 5/2) mottles; moderate medium prismatic structure; firm; few fine roots; about 5 percent by volume of gravel; some grains of very fine sand along faces of prisms; slight effervescence; mildly alkaline; gradual wavy boundary.

IIC—36 to 60 inches; reddish brown (5YR 5/3) silty clay loam; many fine faint brown (7.5YR 4/4) and prominent light olive gray (5Y 6/2) mottles; massive; firm;

about 5 percent by volume of gravel; common medium pink (5YR 7/3) lime segregations in upper few inches, few below; strong effervescence; moderately alkaline.

Thickness of the solum typically is 30 to 40 inches but ranges from 24 to 45 inches. Thickness of the coarser textured water-laid sediment is 18 to 36 inches. The solum ranges from slightly acid to mildly alkaline. Free carbonates are just below the solum or in the B3 horizon.

The Ap horizon has color value of 2 or 3 and chroma of 1 or 2. The B2 horizon has 10YR or 7.5YR hue, value of 4 or 5, and chroma of 2 through 4. It contains varying strata of silt, very fine sand, and fine sand. It averages between 15 and 50 percent fine sand or coarser. Thin lenses or layers of coarser sand and fine gravel are in the B23 horizon of some pedons. Some pedons have no IIB horizon. The IIB horizon and the IIC horizon have value of 4 or 5 and chroma of 3 or 4. They are silty clay, clay, clay loam, or silty clay loam. They are as much as 20 percent by volume gravel. The IIC horizon is mildly or moderately alkaline.

Lamartine series

The Lamartine series consists of somewhat poorly drained, moderately permeable soils formed in silty material and the underlying loamy glacial till. The glacial till has a high content of carbonates and dolomite fragments. These soils are on valley terraces and in drainageways on uplands. Slopes are 0 to 3 percent.

Lamartine soils formed in material similar to that in which the nearby Atterberry, Lomira, and Ossian soils formed. The somewhat poorly drained Atterberry soils, in similar landscape positions, and the poorly drained Ossian soils, on nearby lowlands, formed in thicker deposits of silty material and have a silt loam C horizon. Lomira soils, on adjacent uplands, do not have mottles with chroma of 2 or less in the upper 10 inches of the Bt horizon.

Typical pedon in an area of Lamartine silt loam, 0 to 3 percent slopes, 120 feet south and 50 feet west of northeast corner NW1/4 sec. 26, T. 17 N., R. 15 E.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine granular structure; friable; common fine roots; neutral; abrupt smooth boundary.

B1t—9 to 14 inches; brown (10YR 4/3) silty clay loam; common fine faint grayish brown (10YR 5/2) inped mottles; common fine prominent strong brown (7.5YR 5/6) inped and exped mottles; weak very fine subangular blocky structure; friable; common fine roots; common thin dark brown (7.5YR 4/2) clay films on faces of peds; few fine dark reddish brown (5YR 2/2) inped concretions; neutral; clear wavy boundary.

B2t—14 to 25 inches; brown (10YR 5/3) silty clay loam; many medium faint grayish brown (10YR 5/2) inped mottles; common fine prominent strong brown (7.5YR 5/6) inped and exped mottles; moderate fine subangular blocky structure; friable; common fine roots; common thin dark brown (7.5YR 4/2) clay films on faces of peds; common fine dark reddish brown (5YR 2/2) inped concretions; neutral; clear wavy boundary.

IIB3tg—25 to 30 inches; grayish brown (2.5YR 5/2) loam; common fine prominent yellowish brown (10YR 5/8) inped and exped mottles; weak medium subangular blocky structure; friable; few fine roots; few thin dark brown (7.5YR 4/2) clay films on faces of peds; many fine dark reddish brown (5YR 2/2) inped concretions; about 7 percent by volume of gravel; mildly alkaline; clear wavy boundary.

IIC—30 to 60 inches; brown (10YR 5/3) and pale brown (10YR 6/3) gravelly fine sandy loam; many medium faint grayish brown (10YR 5/2) mottles and common fine prominent yellowish brown (10YR 5/6) mottles; massive; very friable; common fine dark reddish brown (5YR 2/2) concretions; about 30 percent by volume of gravel; strong effervescence; moderately alkaline (calcium carbonate equivalent 65 percent).

Thickness of the solum ranges from 24 to 40 inches. Thickness of the upper silty material ranges from 20 to 36 inches.

The Ap horizon has value of 2 or 3 and chroma of 1 or 2. Some pedons have a thin A2 horizon. The B horizon, in the upper silty material, has value of 4 or 5, and chroma of 2 through 4. It is silt loam or silty clay loam. It is slightly acid or neutral. The IIB horizon has 10YR or 2.5Y hue, value of 4 through 6, and chroma of 2 or 3. It is loam or clay loam that is about 5 to 15 percent by volume gravel. It is neutral or mildly alkaline. The IIC horizon has a calcium carbonate equivalent of 60 to 90 percent. It is about 20 to 40 percent by volume gravel.

LeRoy series

The LeRoy series consists of well drained, moderately permeable soils formed mostly in silty material and partly in the underlying loamy glacial till. The glacial till has a high content of carbonates and dolomite fragments (fig. 8). These soils are on side slopes and crests of drumlins, on knolls, and on morainic ridges of till plains. Slopes are 2 to 12 percent.

LeRoy soils formed in the same kind of material as Hochheim soils and the nearby Lamartine and Lomira soils. Hochheim soils have a mollic epipedon and a calcium carbonate equivalent of 40 to 60 percent in the C horizon. Lamartine and Lomira soils are in lower landscape positions, where the silty mantle is thicker, and contain less sand in the control section. Lamartine soils are mottled in the upper part of the Bt horizon.

Typical pedon in an area of LeRoy silt loam, 6 to 12 percent slopes, eroded, 240 feet south and 695 feet

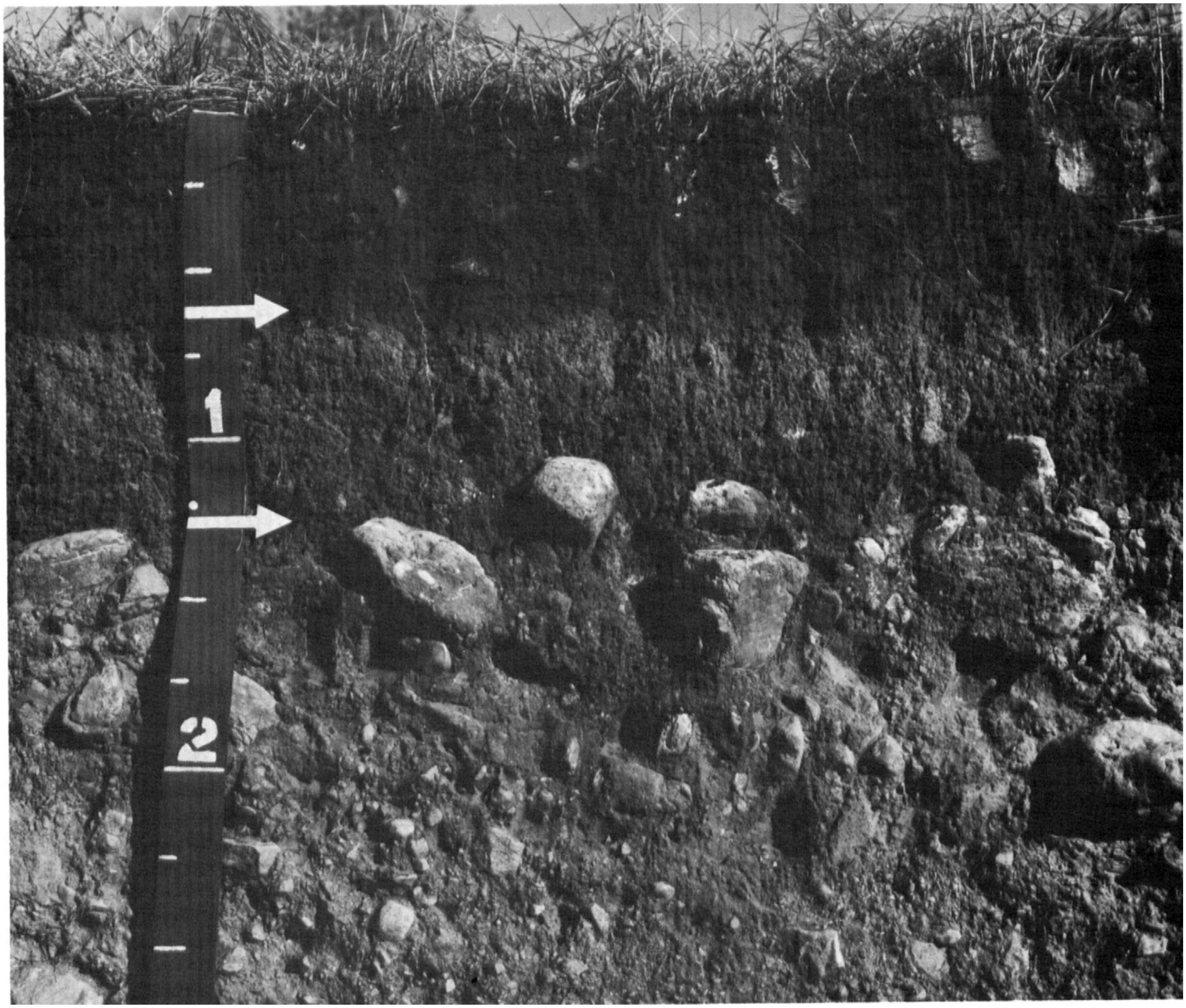


Figure 8.—Profile of LeRoy silt loam showing high content of limestone fragments in substratum. The scale is in feet.

west of northeast corner SE1/4NW1/4 sec. 29, T. 17 N., R. 15 E.

Ap—0 to 8 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; very friable; common fine roots; neutral; abrupt smooth boundary.

B1—8 to 10 inches; dark yellowish brown (10YR 4/4) silt loam; weak very fine subangular blocky structure; very friable; common fine roots; common very dark grayish brown (10YR 3/2) worm casts; neutral; abrupt wavy boundary.

B21t—10 to 16 inches; dark brown (10YR 4/3) silty clay loam; moderate very fine subangular blocky structure; friable; common fine roots; many thin clay films on faces of peds; estimated 15 percent sand; neutral; abrupt wavy boundary.

IIB22t—16 to 19 inches; dark brown (7.5YR 4/4) clay loam; moderate very fine subangular blocky struc-

ture; friable; common fine roots; many moderately thick dark brown (7.5YR 3/2) clay films on faces of peds; about 10 percent by volume of gravel; mildly alkaline; abrupt wavy boundary.

IIC—19 to 60 inches; yellowish brown (10YR 5/4) gravelly fine sandy loam; massive; very friable; about 40 percent by volume of gravel; strong effervescence; moderately alkaline (calcium carbonate equivalent 70 percent).

Thickness of the solum ranges from 12 to 24 inches. Thickness of the upper silty material ranges from 10 to 20 inches.

The Ap horizon has value of 3 or 4. Reaction in the upper silty material of the B horizon ranges from medium acid to neutral. The IIB horizon is loam or clay loam that is about 5 to 15 percent by volume gravel. Reaction is neutral or mildly alkaline. The IIC horizon has a calcium carbonate equivalent of 60 to 90 percent. It is about 20 to 40 percent by volume gravel.

Lomira series

The Lomira series consists of well drained, moderately permeable soils formed mostly in silty material and the underlying loamy glacial till. The glacial till has a high content of carbonates and dolomite fragments. These soils are on the lower side slope of drumlins, on knolls, and on morainic ridges of till plains. Slopes are 2 to 6 percent.

Lomira soils formed in the same kind of material as the nearby Lamartine, LeRoy, and St. Charles soils. The somewhat poorly drained Lamartine soils, in the lower landscape positions, are mottled in the upper part of the Bt horizon. LeRoy soils are in higher landscape positions where the silty mantle is less than 20 inches thick and the solum is less than 24 inches thick. St. Charles soils are in similar landscape positions where the silty mantle is more than 40 inches thick. Consequently, they have a thicker solum.

Typical pedon in an area of Lomira silt loam, 2 to 6 percent slopes, 345 feet south and 545 feet west of northeast corner SE1/4NW1/4 sec. 29, T. 17 N., R. 15 E.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) silt loam, light brownish gray (10YR 6/2) dry; weak fine subangular blocky structure; very friable; common fine roots; many worm casts; neutral; abrupt smooth boundary.

B1—9 to 12 inches; brown (10YR 4/3) silt loam; weak very fine subangular blocky structure; very friable; common fine roots; common very dark grayish brown (10YR 3/2) worm casts; neutral; abrupt wavy boundary.

B21t—12 to 20 inches; dark yellowish brown (10YR 4/4) silt loam; weak fine subangular blocky structure; friable; common fine roots; common thin clay films on faces of peds; slightly acid; gradual wavy boundary.

B22t—20 to 32 inches; dark brown (10YR 4/3) silty clay loam; moderate fine subangular blocky structure; friable; common fine roots; many thin clay films on faces of peds; neutral; abrupt wavy boundary.

IIB23t—32 to 37 inches; dark brown (7.5YR 4/4) clay loam; moderate fine subangular blocky structure; friable; few fine roots; many moderately thick dark brown (7.5YR 3/2) clay films on faces of peds; about 10 percent by volume of gravel; mildly alkaline; abrupt wavy boundary.

IIC—37 to 60 inches; yellowish brown (10YR 5/4) gravelly fine sandy loam; massive; very friable; about 40 percent by volume of gravel; strong effervescence; moderately alkaline (calcium carbonate equivalent 65 percent).

Thickness of the solum ranges from 24 to 40 inches. Thickness of the upper silty material ranges from 20 to 36 inches.

The Ap horizon has value of 3 or 4. Reaction in the upper silty material in the B horizon ranges from medium acid to neutral. The IIB horizon is loam or clay loam that is about 5 to 15 percent by volume gravel. Reaction is neutral or mildly alkaline. The IIC horizon has a calcium carbonate equivalent of 60 to 90 percent. It is about 20 to 40 percent by volume gravel.

Lorenzo Variant

The Lorenzo Variant consists of moderately well drained soils formed in loamy outwash over very gravelly outwash and loamy or clayey glacial till. Permeability is moderate over slow or moderately slow. These soils are on glacial till moraines in some of the highest positions of the landscape. Slopes are 2 to 8 percent.

Lorenzo Variant soils have a IIC horizon similar to that of Casco and Fox soils. Casco and Fox soils do not have the loamy or clayey IIIC horizon within depths of 24 to 40 inches. Fox soils have a solum 24 to 40 inches thick.

Typical pedon in an area of Lorenzo Variant loam, 2 to 8 percent slopes, 855 feet south and 395 feet east of northwest corner SE1/4 sec. 34, T. 18 N., R. 16 E.

Ap—0 to 9 inches; very dark grayish brown (10YR 3/2) loam, dark brown (10YR 4/3) dry; weak fine subangular blocky structure; friable; many fine roots; neutral; abrupt smooth boundary.

B2t—9 to 14 inches; dark brown (7.5YR 4/4) clay loam; moderate fine subangular blocky structure; friable; many fine roots; continuous thin dark reddish brown (5YR 3/3) clay films on faces of peds; neutral; abrupt wavy boundary.

B3t—14 to 19 inches; brown (7.5YR 4/4) gravelly sandy loam; weak medium subangular blocky structure; very friable; many fine roots; many thin clay bridges between mineral grains; about 40 percent by volume of gravel; about 10 percent by volume of cobble-

stones; slight effervescence; mildly alkaline; abrupt wavy boundary.

IIC1—19 to 32 inches; brown (7.5YR 5/4) very gravelly loamy sand; common medium distinct strong brown (7.5YR 5/6) mottles; single grained; loose; few fine roots; about 63 percent by volume of gravel; about 15 percent by volume of cobblestones; strong effervescence; mildly alkaline; abrupt wavy boundary.

IIIC2—32 to 60 inches; reddish brown (5YR 5/3) clay loam; common fine prominent gray (5Y 6/1) and yellowish red (5YR 5/6) mottles; massive; firm; about 17 percent by volume of gravel; few cobblestones; common pink (5YR 7/3) lime segregations; strong effervescence; mildly alkaline.

Thickness of the solum ranges from 12 to 27 inches. Depth to the IIIC horizon ranges from 24 to 40 inches. The Bt horizon has no mottles with chroma of 2 or less. Free carbonates are in the B3 horizon or just below the solum. The IIC horizon is seasonally saturated.

The Ap horizon has value of 2 or 3. It is slightly acid to mildly alkaline.

The B2t horizon has 10YR, 7.5YR, or 5YR hue and value and chroma of 3 or 4. It is loam, clay loam, or sandy clay loam that is as much as 20 percent by volume gravel. It is slightly acid to mildly alkaline. The B3t horizon has 10YR or 7.5YR hue, value of 4 or 5, and chroma of 3 or 4. It is gravelly or very gravelly sandy loam or loamy sand that is about 20 to 60 percent by volume gravel and as much as 10 percent by volume cobblestones. It ranges from neutral to moderately alkaline.

The IIC1 horizon has 10YR or 7.5YR hue, value of 4 through 6, and chroma of 2 through 4. It is very gravelly loamy sand or sand that is about 55 to 75 percent by volume gravel and as much as 15 percent by volume cobblestones. It is mildly or moderately alkaline. The IIIC2 horizon is clay loam, silty clay loam, silty clay, or clay that is as much as 20 percent by volume gravel. It is mildly or moderately alkaline.

Manawa series

The Manawa series consists of somewhat poorly drained, slowly permeable soils formed in clayey or loamy glacial till. These soils are on valley terraces and in upland drainageways. Slopes are 0 to 3 percent.

Manawa soils formed in the same kind of material as the nearby Kewaunee and Poygan soils. Kewaunee soils, in higher landscape positions, do not have mottles with chroma of 2 or less. The poorly drained Poygan soils are in depressional areas.

Typical pedon in an area of Manawa silty clay loam, 0 to 3 percent slopes, 805 feet south and 160 feet east of northwest corner SW1/4 sec. 12, T. 17 N., R. 16 E.

Ap—0 to 9 inches; very dark gray (10YR 3/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; many fine roots; neutral; abrupt smooth boundary.

B21t—9 to 15 inches; reddish brown (5YR 4/4) silty clay loam; many medium distinct brown (7.5YR 5/2) and common fine faint dark brown (7.5YR 4/4) mottles; strong fine angular and subangular blocky structure; firm; many fine roots; many thin clay films on faces of peds; about 3 percent by volume of gravel; neutral; clear wavy boundary.

B22t—15 to 26 inches; reddish brown (5YR 4/3) silty clay; many medium distinct grayish brown (10YR 5/2) and many medium prominent strong brown (7.5YR 5/6) mottles; moderate fine prismatic structure parting to strong fine subangular blocky; firm; many fine roots; common thin clay films on faces of peds; about 8 percent by volume of gravel; neutral; clear wavy boundary.

B3—26 to 35 inches; reddish brown (5YR 4/3) silty clay; many medium prominent gray (5YR 5/1) mottles; moderate medium prismatic structure; firm; few fine roots; about 5 percent by volume of gravel; many pink (5YR 7/3) lime segregations; faces of prisms almost totally gleyed; strong effervescence; mildly alkaline; gradual wavy boundary.

C—35 to 60 inches; reddish brown (5YR 4/3) silty clay; common medium prominent gray (5YR 5/1) mottles; massive; firm; about 5 percent by volume of gravel; few pink (5YR 7/3) lime segregations; strong effervescence; moderately alkaline.

Thickness of the solum ranges from 26 to 40 inches. Some pedons have an upper mantle of silty material less than 20 inches thick. The solum commonly ranges from slightly acid to mildly alkaline but is moderately alkaline in the lower part of some pedons. Free carbonates are just below the solum or in the B3 horizon. The solum is as much as 10 percent by volume gravel.

The Ap horizon has 10YR or 7.5YR hue, value of 2 or 3, and chroma of 1 or 2. It is 6 to 9 inches thick. Some pedons have an A1 and A2 horizon. The B horizon has value of 4 or 5 and chroma of 3 or 4. It commonly is silty clay loam, silty clay, or clay, but subhorizons of clay loam are in some pedons. The C horizon is clay, silty clay, clay loam, or silty clay loam. It is mildly or moderately alkaline. It is as much as 10 percent by volume gravel.

McHenry series

The McHenry series consists of well drained, moderately permeable soils formed in silty material and the underlying loamy glacial till. These soils are on valley sides and on low hills and morainic ridges of till plains. Slopes are 2 to 12 percent.

McHenry soils formed in the same kind of material as the nearby Kidder, St. Charles, and Whalan soils. Kidder soils, in similar landscape positions, contain more sand in the upper part of the solum. St. Charles soils com-

monly are in slightly lower landscape positions where the silty material is thicker. Consequently, the control section is fine-silty. Whalan soils are 20 to 40 inches deep over limestone bedrock.

Typical pedon in an area of McHenry silt loam, 2 to 6 percent slopes, 530 feet south and 660 feet east of northwest corner SE1/4 sec. 28, T. 17 N., R. 14 E.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) silt loam; weak medium subangular blocky structure; very friable; common fine roots; neutral; abrupt smooth boundary.

B1—9 to 14 inches; dark brown (10YR 4/3) silt loam; weak very fine subangular blocky structure; friable; few fine roots; few dark grayish brown (10YR 4/2) worm casts; slightly acid; clear wavy boundary.

B21t—14 to 21 inches; dark yellowish brown (10YR 4/4) silt loam; moderate very fine subangular blocky structure; friable; few fine roots; many thin dark brown (7.5YR 4/4) clay films on faces of peds; medium acid; abrupt wavy boundary.

IIB22t—21 to 32 inches; dark brown (7.5YR 4/4) clay loam; moderate fine subangular blocky structure; friable; few fine roots; common moderately thick dark brown (7.5YR 3/2) clay films on faces of peds; about 12 percent by volume of gravel; few dolomite cobblestones; slightly acid; clear wavy boundary.

IIC—32 to 60 inches; yellowish brown (10YR 5/4) fine sandy loam; moderate thin platy structure; very friable; few fine roots in upper part; about 8 percent by volume of gravel; slight effervescence; moderately alkaline (calcium carbonate equivalent 35 percent).

Thickness of the solum ranges from 30 to 40 inches, the same as the depth to carbonates. Thickness of the upper silty material ranges from 15 to 30 inches. The lower part of the solum is up to 15 percent by volume gravel.

The Bt horizon is silt loam or silty clay loam. It ranges from slightly to strongly acid. The IIBt horizon is clay loam, sandy clay loam, or sandy loam. It is slightly acid or neutral. The IIC horizon is sandy loam or fine sandy loam. It is 5 to 35 percent by volume gravel.

Menasha series

The Menasha series consists of poorly drained, slowly or very slowly permeable soils formed in clayey water-laid sediment. These soils are in slightly depressed areas in lake basins and on stream terraces. Slopes are 0 to 2 percent.

Menasha soils formed in the same kind of material as the nearby Neenah and Winneconne soils. The somewhat poorly drained Neenah soils and the moderately well drained Winneconne soils, in slightly higher landscape positions, do not have matrix colors with chroma of 2 or less in the upper part of the B horizon.

Typical pedon in an area of Menasha clay, 1,270 feet south and 1,270 feet west of northeast corner SE1/4 sec. 20, T. 20 N., R. 15 E.

Ap—0 to 7 inches; black (10YR 2/1) clay, dark gray (10YR 9/1) dry; moderate fine and medium granular structure; firm; many fine roots; mildly alkaline; abrupt smooth boundary.

B11g—7 to 11 inches; very dark gray (5Y 3/1) clay, grayish brown (10YR 5/2) dry; many fine prominent dark brown (7.5YR 4/4) mottles; moderate fine subangular blocky structure; firm; many fine roots; mildly alkaline; abrupt wavy boundary.

B12g—11 to 13 inches; dark gray (5Y 4/1) clay; many fine prominent dark yellowish brown (10YR 4/4) mottles; moderate fine subangular blocky structure; firm; many fine roots; mildly alkaline; abrupt wavy boundary.

B2g—13 to 17 inches; gray (5Y 5/1) clay; many fine prominent light olive brown (2.5Y 5/4) and common fine prominent dark brown (7.5YR 4/4) and reddish brown (5YR 5/3) mottles; moderate fine angular blocky structure; firm; common fine roots; mildly alkaline; clear irregular boundary.

B3—17 to 26 inches; gray (5Y 5/1) and reddish brown (5YR 4/3) clay; common fine distinct light olive brown (2.5Y 5/4) mottles; moderate coarse prismatic structure; firm; few fine roots; mildly alkaline; clear irregular boundary.

C—26 to 60 inches; reddish brown (5YR 4/3) clay; many medium prominent gray (5Y 5/1) mottles; moderate thick platy structure; firm; few fine roots; strong effervescence; mildly alkaline.

Thickness of the solum ranges from 18 to 30 inches. The solum ranges from slightly acid to moderately alkaline. Free carbonates are just below the solum or in the B3 horizon.

The Ap horizon has 10YR or N hue, value of 2 or 3, and chroma of 0 or 1. The B and C horizons commonly are clay, but subhorizons of silty clay are in some pedons. The B1g horizon has N, 10YR, 2.5Y or 5Y hue, value of 3 or 4, and chroma of 0 or 1. The B2g horizon has 10YR, 2.5Y or 5Y hue, value of 4 through 6, and chroma of 1 or 2. The B3 and C horizons have value of 4 or 5 and chroma of 3 or 4. The C horizon is mildly or moderately alkaline. A few thin strata of very fine sand or silt are in the C horizon of some pedons.

Morocco series

The Morocco series consists of somewhat poorly drained, rapidly permeable soils formed in thick deposits of sand. These soils are on terraces that are adjacent to drainageways, basins, and lakes. Slopes are 0 to 3 percent. The Morocco soils in this survey area are outside the defined limits for the series because they do not have mottles with chroma of 2. This difference, however, does not alter the use or behavior of the soils.

Morocco soils are similar to Brems and Kingsville soils and are near those soils and Nebago soils. The moderately well drained Brems soils, in slightly higher landscape positions, formed in similar material but do not have mottles within a depth of 20 inches. The poorly drained Kingsville soils, on adjacent lowlands, formed in similar material but have matrix colors with chroma of 2 or less throughout the B horizon. Nebago soils are sandy over clayey.

Typical pedon in an area of Morocco loamy fine sand, 0 to 3 percent slopes, 130 feet south and 2,340 feet east of northeast corner sec. 30, T. 20 N., R. 14 E.

Ap—0 to 7 inches; dark brown (10YR 3/3) loamy fine sand; weak fine subangular blocky structure; very friable; many fine roots; medium acid; abrupt smooth boundary.

B2—7 to 18 inches; yellowish brown (10YR 5/4) fine sand; weak coarse subangular blocky structure; very friable; few fine roots; medium acid; clear wavy boundary.

B31—18 to 32 inches; pale brown (10YR 6/3) fine sand; many coarse prominent strong brown (7.5YR 5/6) and yellowish brown (10YR 5/8) mottles; single grained; loose; few fine roots; saturated with water; medium acid; clear wavy boundary.

B32—32 to 38 inches; pale brown (10YR 6/3) fine sand; few medium prominent brownish yellow (10YR 6/6) and reddish yellow (7.5YR 6/8) mottles; single grained; loose; saturated with water; medium acid; gradual wavy boundary.

C—38 to 60 inches; pale brown (10YR 6/3) fine sand; single grained; loose; saturated with water; medium acid.

Thickness of the solum ranges from 24 to 40 inches.

The Ap horizon has value of 3 or 4 and chroma of 1 through 3. It is medium or slightly acid. Some pedons have an A1 horizon less than 5 inches thick. The B horizon averages between 20 and 40 percent medium sand and between 50 to 65 percent sand. It ranges from medium to very strongly acid. The C horizon is medium or fine sand. It is medium or strongly acid.

Mosel series

The Mosel series consists of somewhat poorly drained soils that are moderately permeable in the upper part and slowly or moderately slowly permeable in the lower part. These soils formed in silty material over loamy outwash and in the underlying loamy or clayey glacial till. They are on valley terraces and in drainageways and swales in the uplands. Slopes are 0 to 3 percent.

Mosel soils are similar to Korobago, Manawa, and Navan soils in having the same kind of material in the C horizon. The somewhat poorly drained Korobago soils have an upper B horizon formed in silty, sandy, and loamy lacustrine sediment. They are coarse-loamy over clayey. The somewhat poorly drained Manawa soils do not have the upper outwash material but have a clayey control section. The poorly drained Navan soils have similar texture in the B horizon. The upper part of their B horizon is dominated by chroma of 2 or less.

Typical pedon in an area of Mosel silt loam, 0 to 3 percent slopes, 290 feet east and 595 feet north of southwest corner SE1/4 sec. 26, T. 17 N., R. 16 E.

Ap—0 to 9 inches; very dark gray (10YR 3/1) silt loam; grayish brown (10YR 5/2) dry; weak very fine subangular blocky structure; friable; many fine roots; neutral; abrupt smooth boundary.

A2—9 to 14 inches; dark grayish brown (10YR 4/2) silt loam; few fine prominent strong brown (7.5YR 5/6) and yellowish red (5YR 4/8) mottles; weak very fine subangular blocky structure; friable; many fine roots; few very dark gray (10YR 3/1) worm casts; mildly alkaline; abrupt wavy boundary.

IIB21t—14 to 24 inches; reddish brown (5YR 4/3) clay loam; common fine distinct brown (7.5YR 5/2) mottles and common medium prominent strong brown (7.5YR 5/6) and yellowish red (5YR 4/8) mottles; moderate medium subangular blocky structure; friable; many fine roots; many thin dark reddish brown (5YR 3/4) clay films on faces of peds; about 10 percent by volume of gravel; mildly alkaline; abrupt wavy boundary.

IIB22t—24 to 26 inches; brown (10YR 5/3) clay loam; many medium prominent yellowish brown (10YR 5/6) mottles and common medium distinct grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; friable; many fine roots; few thin dark brown (7.5YR 4/2) clay films on faces of peds; about 13 percent by volume of gravel; slight effervescence; mildly alkaline; abrupt wavy boundary.

IIIB31t—26 to 33 inches; reddish brown (5YR 4/4) silty clay; many coarse prominent olive gray (5Y 5/2) mottles, many medium prominent yellowish red (5YR 4/8) mottles, and many medium distinct strong brown (7.5YR 5/6) mottles; moderate medium prismatic structure parting to moderate medium angular and subangular blocky; firm; few thin clay films on faces of peds; about 5 percent by volume of gravel; few light reddish brown (5YR 6/4) lime segregations; strong effervescence; mildly alkaline; clear wavy boundary.

IIIB32—33 to 38 inches; reddish brown (5YR 4/4) silty clay; many coarse prominent gray (5Y 6/1) mottles and common medium distinct strong brown (7.5YR 5/6) mottles; moderate coarse prismatic structure; firm; few fine roots; about 5 percent by volume of gravel; massive in interior of prisms; faces of prisms are totally gleyed; common light reddish brown (5YR 6/4) lime segregations; strong effervescence; moderately alkaline; gradual wavy boundary.

IIIC—38 to 60 inches; reddish brown (5YR 4/4) silty clay; common fine prominent gray (5Y 6/1) mottles and common medium distinct strong brown (7.5YR 5/6) mottles; massive; firm; about 5 percent by volume of

gravel; many light reddish brown (5YR 6/4) lime segregations; violent effervescence; moderately alkaline.

Thickness of the solum ranges from 24 to 40 inches, commonly more than the depth to carbonates. The upper mantle of silty material is less than 18 inches thick. It is neutral or mildly alkaline and is 5 to 20 percent by volume gravel. The finer textured material is as much as 10 percent by volume gravel.

The Ap horizon has value of 2 or 3 and chroma of 1 or 2. The A2 horizon is silt loam or loam. The IIB2t horizon has 10YR, 7.5YR or 5YR hue, value of 4 or 5, and chroma of 3 or 4. It is loam, clay loam, or sandy clay loam. The IIIB and IIIC horizons are mildly or moderately alkaline. They are clay, silty clay, silty clay loam, or clay loam.

Navan series

The Navan series consists of poorly drained soils that are moderately permeable in the upper part and slowly or moderately slowly permeable in the lower part. These soils formed in silty material over loamy outwash and in the underlying loamy or clayey glacial till. They are in drainageways and swales in the uplands. Slopes are 0 to 2 percent. The Navan soils in this survey area are outside the defined limits for the series because there is no evidence of illuvial clay in the B horizon. This difference, however, does not alter the use or behavior of the soils.

Navan soils formed in the same kind of material as the nearby Mosel soils. In Navan, Poygan, and Wauseon soils, the C horizon is more than 35 percent clay. The somewhat poorly drained Mosel soils do not have matrix colors with chroma of 2 or less in the upper part of the B horizon. The poorly drained Poygan soils have less gravel and more clay in the B horizon. The poorly drained Wauseon soils have less gravel and less clay in the B horizon.

Typical pedon in an area of Navan silt loam, 525 feet east and 820 feet north of southwest corner SE1/4 sec. 26, T. 17 N., R. 16 E.

Ap—0 to 9 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak very fine granular structure; friable; many fine roots; neutral; abrupt smooth boundary.

A12—9 to 12 inches; black (10YR 2/1) silt loam; weak medium subangular blocky structure; friable; many fine roots; neutral; abrupt wavy boundary.

B1g—12 to 18 inches; olive gray (5Y 5/2) silt loam; common fine prominent strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; friable; many fine roots; dark gray (5Y 4/1) in about 20 percent of the horizon; mildly alkaline; abrupt irregular boundary.

IIB2—18 to 30 inches; reddish brown (5YR 4/3) clay loam; many medium prominent gray (5Y 5/1) mottles, many fine prominent yellowish red (5YR 4/8) mottles, and common medium prominent strong brown (7.5YR 5/6) mottles; weak fine and medium subangular blocky structure; friable; many fine roots; about 13 percent by volume of gravel; few pockets of loam and sandy loam; many soft yellow (5Y 7/6) dolomite pebbles; mildly alkaline; clear wavy boundary.

IIB3—30 to 38 inches; reddish brown (5YR 4/3) clay loam; many coarse prominent gray (5Y 6/1) mottles and many medium prominent strong brown (7.5YR 5/6) mottles; moderate medium prismatic structure; firm; few fine roots; about 8 percent by volume of gravel; totally gleyed on faces of prisms; slight effervescence; mildly alkaline; clear wavy boundary.

IIIC—38 to 60 inches; reddish brown (5YR 4/3) silty clay; common fine prominent gray (5Y 6/1) mottles and many medium prominent strong brown (7.5YR 5/6) mottles; massive; firm; about 5 percent by volume of gravel; common light reddish brown (5YR 6/4) lime segregations; violent effervescence; moderately alkaline.

Thickness of the solum ranges from 20 to 40 inches, commonly somewhat more than the depth to free carbonates. The upper mantle of silty material is less than 18 inches thick. The IIB2 horizon is neutral or mildly alkaline. It is 5 to 20 percent by volume gravel. The IIIC horizon is as much as 10 percent by volume gravel. The mollic epipedon is 10 to 15 inches thick.

The A1 or Ap horizon has value of 2 or 3 and chroma of 1 or 2. The A12 and B1g horizons commonly are silt loam, but in some pedons they are loam. Some pedons have no B1g horizon. The IIB horizon has 5YR, 7.5YR, 10YR, 2.5Y, or 5Y hue, value of 4 through 6, and chroma of 1 through 4. It is loam, clay loam, or sandy clay loam. The IIB3 and IIIC horizons are mildly or moderately alkaline. They are clay, silty clay, silty clay loam, or clay loam.

Nebago series

The Nebago series consists of somewhat poorly drained soils that are rapidly permeable in the upper part and slowly or moderately slowly permeable in the lower part. These soils formed in sandy deposits and the underlying clayey water-laid sediment or the glacial till. They are mostly in broad glacial lake basins and on sand knolls, and ridges, and terraces. They are also in upland drainageways. Slopes are 0 to 3 percent.

Nebago soils are similar to the nearby Nebago Variant and Tustin soils. They are near Brems, Manawa, Neenah, and Zittau soils. The moderately well drained Brems soils are in similar landscape positions where the sandy deposits are more than 60 inches thick. Manawa, Neenah, and Zittau soils, in the lower landscape positions, do not have the upper sandy deposits. Manawa and Neenah soils are clayey. Zittau soils are clayey over

sandy or sandy-skeletal. The well drained Tustin soils and poorly drained Nebago Variant soils formed in similar material.

Typical pedon in an area of Nebago fine sand, 0 to 3 percent slopes, 30 feet west and 600 feet south of northeast corner sec. 4, T. 19 N., R. 15 E.

Ap—0 to 9 inches; very dark brown (10YR 2/2) fine sand; weak fine subangular blocky structure; very friable; common fine roots; slightly acid; abrupt smooth boundary.

B11—9 to 13 inches; brown (10YR 4/3) fine sand; few fine prominent dark reddish brown (2.5YR 3/4), common medium prominent strong brown (7.5YR 5/6), and common fine faint brown (10YR 5/3) mottles; weak medium subangular blocky structure; very friable; common fine roots; common very dark brown (10YR 2/2) worm casts; slightly acid; clear wavy boundary.

B12—13 to 20 inches; dark yellowish brown (10YR 4/4) fine sand; few medium prominent dark red (2.5YR 3/6), many medium distinct strong brown (7.5YR 5/6), and common medium distinct grayish brown (10YR 5/2) mottles; single grained; loose; common fine roots; neutral; clear wavy boundary.

B13—20 to 32 inches; grayish brown (10YR 5/2) fine sand; few coarse prominent yellowish brown (10YR 5/8) mottles; single grained; loose; few fine roots; neutral; abrupt smooth boundary.

B21—32 to 34 inches; brown (7.5YR 4/4) fine sandy loam; common medium distinct strong brown (7.5YR 5/6) and faint brown (10YR 5/3) mottles; weak fine subangular blocky structure; very friable; few fine roots; neutral; abrupt smooth boundary.

IIB22—34 to 38 inches; reddish brown (5YR 4/4) clay; common fine faint brown (7.5YR 4/4) and many fine prominent greenish gray (5GY 6/1) mottles; moderate medium prismatic structure parting to moderate medium angular blocky; firm; few fine roots; faces of prisms are 80 percent light brownish gray (10YR 6/2); neutral; clear wavy boundary.

IIB3—38 to 46 inches; reddish brown (5YR 4/3) clay; common fine faint brown (7.5YR 4/4) and many fine prominent greenish gray (5GY 6/1) mottles; weak coarse prismatic structure; firm; few fine roots; faces of prisms are light reddish brown (5YR 6/3); weak thin platy structure between faces of prisms; neutral; clear wavy boundary.

IIC—46 to 60 inches; reddish brown (5YR 4/3) clay; many fine prominent greenish gray (5GY 6/1) mottles; moderate thin platy structure; firm; slight effervescence with pink (5YR 7/3) lime segregated in soft masses; mildly alkaline.

Thickness of the solum ranges from 30 to 50 inches. The sandy material is 20 to 40 inches thick. It is medium acid to neutral. The clayey or loamy material is slightly acid to mildly alkaline. Free carbonates are below a depth of 40 inches. The glacial till is 2 to 10 percent by volume dolomite gravel.

The Ap horizon has value of 2 through 4 and chroma of 1 through 3. Some pedons have A1 and A2 horizons. The B1 horizon commonly is fine sand, but in some places it is loamy fine sand. The IIB horizon commonly is clay or silty clay, but some pedons have subhorizons of clay loam or silty clay loam. The IIC horizon commonly is clay or silty clay, but some pedons have thin strata of silty clay loam, silt loam, or fine sand. The IIC horizon ranges from neutral to moderately alkaline. A fine sand or sand IIIC horizon underlies the IIC horizon in some pedons in glacial lake basins. Depth to the IIIC horizon is about 4 feet.

Nebago Variant

The Nebago Variant consists of very poorly drained soils that are rapidly permeable in the upper part and slowly permeable in the lower part. These soils formed in sandy deposits over clayey water-laid sediment. These soils are in depressional areas in glacial lake basins. Slopes are 0 to 2 percent.

Nebago Variant soils are near Kingsville and Nebago soils. The somewhat poorly drained Nebago soils do not have matrix colors with chroma of 2 or less in the upper part of the B horizon. The very poorly drained Kingsville soils are sandy to a depth of 5 feet or more.

Typical pedon in an area of Nebago Variant mucky loamy fine sand, 330 feet west and 460 feet south of northeast corner sec. 20, T. 20 N., R. 15 E.

A1—0 to 7 inches; black (10YR 2/1) mucky loamy fine sand, dark gray (10YR 4/1) dry; weak medium granular structure; very friable; many fine roots; medium acid; abrupt wavy boundary.

B11g—7 to 11 inches; dark gray (10YR 4/1) fine sand; weak coarse subangular blocky structure; very friable; common fine roots; few discontinuous thin lenses of black (10YR 2/1) mucky fine sand; slightly acid; clear irregular boundary.

B12g—11 to 25 inches; dark grayish brown (10YR 4/2) and brown (10YR 5/3) fine sand; many medium prominent yellowish brown (10YR 5/6) mottles; single grained; loose; few fine roots; slightly acid; abrupt smooth boundary.

IIB21g—25 to 26 inches; grayish brown (2.5Y 5/2) loam; many medium prominent strong brown (7.5YR 5/6) and common fine faint gray (5Y 6/1) mottles; moderate fine prismatic structure; friable; few fine roots; common dark reddish brown (5YR 3/2) stains on faces of prisms; neutral; abrupt smooth boundary.

IIB22g—26 to 31 inches; reddish gray (5YR 5/2) clay; many medium prominent strong brown (7.5YR 5/6) and gray (5Y 5/1) mottles; moderate medium prismatic structure; firm; few fine roots; faces of prisms totally gleyed; neutral; clear wavy boundary.

IIB3—31 to 43 inches; reddish brown (5YR 5/3) clay; many coarse prominent greenish gray (5GY 5/1)

mottles; weak coarse prismatic structure; firm; few fine roots; mildly alkaline; abrupt smooth boundary.

IIIC—43 to 60 inches; brown (10YR 5/3) sand; common medium faint dark grayish brown (10YR 4/2) mottles; single grained; loose; mildly alkaline.

Thickness of the solum ranges from 30 to 45 inches. The sandy material in the upper part of the profile is 20 to 40 inches thick. It is slightly acid to strongly acid. The IIB22 horizon and IIB3 horizon are 12 or more inches thick. Reaction ranges from slightly acid to mildly alkaline. Depth to the sandy IIIC horizon is more than 40 inches. In some pedons it is more than 60 inches. Reaction is neutral or mildly alkaline. Some pedons have a IIC horizon in clay. Free carbonates are commonly below a depth of 40 inches.

The A1 horizon is 3 to 9 inches thick. The B1g horizon has value of 4 through 6. The IIB21g horizon is less than 3 inches thick. The IIB horizon and IIC horizon commonly are clay, but some pedons have subhorizons of silty clay. The IIIC horizon is medium or fine sand.

Neenah series

The Neenah series consists of somewhat poorly drained, slowly or very slowly permeable soils formed mostly in clayey water-laid sediment. These soils are in glacial lake basins and on lake and stream terraces. Slopes are 0 to 3 percent.

Neenah soils formed in the same kind of material as the nearby Menasha and Winneconne soils. The poorly drained Menasha soils are in depressional areas. Winneconne soils, in slightly higher landscape positions, do not have low chroma mottles in the upper 10 inches of the argillic horizon.

Typical pedon in an area of Neenah silty clay loam, 0 to 3 percent slopes, 250 feet east and 60 feet north of southwest corner sec. 7, T. 19 N., R. 17 E.

Ap—0 to 7 inches; dark brown (7.5YR 3/2) silty clay loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; firm; many fine roots; neutral; abrupt smooth boundary.

B21t—7 to 11 inches; dark reddish brown (5YR 3/4) clay; common fine distinct yellowish red (5YR 4/6) and common medium distinct dark brown (7.5YR 3/2) mottles; moderate fine subangular blocky structure; firm; common fine roots; many worm casts of dark brown (7.5YR 3/2); many thin clay films on faces of peds; mildly alkaline; clear wavy boundary.

B22t—11 to 15 inches; reddish brown (5YR 4/3) clay; common medium prominent yellowish red (5YR 4/6) and common medium distinct grayish brown (10YR 5/2) mottles; moderate very fine angular blocky structure; firm; common fine roots; few worm casts of dark brown (7.5YR 3/2); common thin clay films on faces of peds; mildly alkaline; clear wavy boundary.

B31t—15 to 20 inches; reddish brown (5YR 5/3) clay; common medium prominent yellowish red (5YR 4/6) and many medium prominent grayish brown (2.5YR 5/2) mottles; moderate fine prismatic structure parting to moderate fine angular blocky; firm; common fine roots; common thin clay films on vertical faces of peds; many pinkish gray (5YR 7/2) lime segregations; strong effervescence; moderately alkaline; clear wavy boundary.

B32—20 to 29 inches; reddish brown (5YR 5/3) clay; common medium prominent yellowish red (5YR 4/6) and many coarse prominent grayish brown (2.5YR 5/2) mottles; strong medium prismatic structure parting to moderate thin platy; firm; few fine roots; common pinkish gray (5YR 7/2) lime segregations; strong effervescence; moderately alkaline; gradual wavy boundary.

C—29 to 60 inches; reddish brown (5YR 4/3) clay; common medium prominent yellowish red (5YR 4/6) and common coarse prominent gray (5Y 6/1) mottles; strong thin platy structure; firm; vertical fractures extend down to 48 inches; fracture faces are gray (5Y 6/1); few roots are between the fractures; strong effervescence; moderately alkaline.

The solum ranges from 18 to 32 inches in thickness. It ranges from slightly acid to moderately alkaline. Free carbonates are just below the solum or in the B3 horizon.

The Ap horizon has 10YR or 7.5YR hue, value of 2 or 3, and chroma of 1 or 2. The B horizon commonly is clay, but some pedons have subhorizons of silty clay. The C horizon is mildly or moderately alkaline. Some pedons have a few thin strata of very fine sand or silt in the C horizon.

Nenno series

The Nenno series consists of somewhat poorly drained, moderately permeable soils formed in loamy glacial till. The till has a high content of carbonates and dolomite fragments. These soils are in drainageways and on foot slopes of drumlins on till plains. Slopes are 0 to 3 percent.

Nenno soils formed in the same kind of material as the nearby Hochheim soils. The well drained Hochheim soils do not have mottles with chroma of 2 or less in the upper 10 inches of the argillic horizon.

Typical pedon in an area of Nenno loam, 0 to 3 percent slopes, 150 feet north and 60 feet west of southeast corner NW1/4 sec. 3, T. 19 N., R. 17 E.

Ap—0 to 9 inches; very dark gray (10YR 3/1) loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; many fine roots; about 5 percent by volume of gravel; mildly alkaline; abrupt smooth boundary.

A3—9 to 11 inches; very dark grayish brown (10YR 3/2) loam, grayish brown (10YR 5/2) dry; few fine distinct

brown (7.5YR 4/4) and grayish brown (10YR 5/2) mottles; moderate fine subangular blocky structure; friable; common fine roots; many dark gray (10YR 3/1) worm casts; about 5 percent by volume of gravel; mildly alkaline; abrupt wavy boundary.

B21t—11 to 15 inches; dark brown (10YR 4/3) loam; common fine prominent strong brown (7.5YR 5/6) and common fine faint grayish brown (10YR 5/2) mottles; moderate medium subangular blocky structure; friable; common fine roots; common thin brown (7.5YR 4/2) clay films on faces of peds; few dark gray (10YR 3/1) worm casts; about 9 percent by volume of gravel; mildly alkaline; clear wavy boundary.

B22t—15 to 21 inches; brown (10YR 5/3) loam; common medium prominent strong brown (7.5YR 5/6) and common medium faint grayish brown (10YR 5/2) mottles; weak medium subangular blocky structure; friable; common fine roots; few thin strong brown (7.5YR 5/6) clay films on faces of peds; about 9 percent by volume of gravel; slight effervescence; mildly alkaline; clear wavy boundary.

C—21 to 60 inches; brown (7.5YR 5/4) gravelly fine sandy loam; many medium distinct strong brown (7.5YR 5/6) and brown (7.5YR 5/2) mottles; massive; friable; about 25 percent by volume of gravel; few cobblestones and stones; strong effervescence; moderately alkaline.

Thickness of the solum ranges from 12 to 24 inches. The solum is neutral or mildly alkaline. Free carbonates are in the B3 horizon or just below the solum. The solum is about 2 to 10 percent by volume dolomite gravel.

The Ap horizon has chroma of 1 or 2. Some pedons have no A3 horizon. The B2t horizon has 10YR or 7.5YR hue. It is clay loam or loam. The C horizon has a calcium carbonate equivalent of 40 to 60 percent. It is mildly or moderately alkaline. It is 20 to 30 percent by volume gravel.

Oakville series

The Oakville series consists of well drained, rapidly permeable soils formed in thick deposits of sand. These soils are on terraces and long low ridges in broad glacial lake basins. They are also on hills in the uplands that were formerly actively shifting sand dunes. Slopes are 2 to 12 percent.

Oakville soils are similar to the nearby Brems, Morocco, and Tustin soils. The moderately well drained Brems soils and somewhat poorly drained Morocco soils are in lower landscape positions. They formed in similar material but have mottles with chroma of 2 or less within a depth of 36 inches. Tustin soils have similar horizons in the upper part of the solum but have a loamy or clayey horizon within a depth of 40 inches.

Typical pedon in an area of Oakville fine sand, 6 to 12 percent slopes, 265 feet east and 1,300 feet north of southwest corner NW1/4 sec. 7, T. 20 N., R. 14 E.

A1—0 to 3 inches; very dark gray (10YR 3/1) fine sand; weak fine subangular blocky structure; very friable; many fine roots; strongly acid; abrupt smooth boundary.

A2—3 to 4 inches; dark grayish brown (10YR 4/2) fine sand; weak medium subangular blocky structure; very friable; common fine roots; very strongly acid; abrupt smooth boundary.

B2—4 to 14 inches; yellowish brown (10YR 5/6) fine sand; very weak medium subangular blocky structure; very friable; few fine roots; very strongly acid; clear wavy boundary.

B3—14 to 22 inches; yellowish brown (10YR 5/4) fine sand; very weak coarse subangular blocky structure; very friable; few fine roots; strongly acid; gradual wavy boundary.

C—22 to 60 inches; light yellowish brown (10YR 6/4) fine sand; single grained; loose; few fine roots; medium acid.

Thickness of the solum ranges from 18 to 30 inches. The solum ranges from medium acid to very strongly acid.

The A1 horizon has value of 2 or 3 and chroma of 1 or 2. It is 1 to 4 inches thick. Some pedons have an Ap horizon. Most pedons in cultivated areas have no A2 horizon. The B horizon has 10YR or 7.5YR hue, value of 4 or 5, and chroma of 4 through 6. The C horizon is medium or slightly acid.

Omro series

The Omro series consists of well drained soils that are slowly or moderately slowly permeable in the upper part and moderately permeable in the lower part. These soils formed in a thin mantle of silty or loamy material and the underlying clayey or loamy glacial till. They are on the crests and sides of broad hills on till plains. Slopes are 2 to 6 percent.

Omro soils have a Bt horizon similar to that of Kewaunee soils. They have a C horizon similar to that of Hochheim soils. The C horizon of Kewaunee soils has more clay and less sand and gravel than the C horizon of Omro soils. Hochheim soils have a thinner solum and less clay and more sand in the Bt horizon.

Typical pedon in an area of Omro clay loam, 2 to 6 percent slopes, 400 feet east and 1,200 feet south of northwest corner sec. 18, T. 17 N., R. 17 E.

Ap—0 to 8 inches; dark brown (7.5YR 3/2) clay loam; pinkish gray (7.5YR 6/2) dry; weak fine subangular blocky structure; friable; many fine roots; about 2 percent by volume gravel; neutral; abrupt smooth boundary.

B21t—8 to 13 inches; reddish brown (5YR 4/4) clay; moderate medium subangular blocky structure; firm; many fine roots; common thin clay films on faces of peds; about 5 percent by volume of gravel; common

dark brown (7.5YR 3/2) worm casts; neutral; clear wavy boundary.

B22t—13 to 20 inches; reddish brown (5YR 4/3) clay; strong very fine angular blocky structure; firm; common fine roots; many thin clay films on faces of peds; about 8 percent by volume of gravel; few dark brown (7.5YR 3/2) worm casts; neutral; clear wavy boundary.

B23t—20 to 28 inches; reddish brown (5YR 4/3) silty clay; moderate fine prismatic structure parting to strong fine angular blocky; firm; common fine roots; many thin clay films on faces of peds; about 8 percent by volume of gravel; about 5 percent by volume of cobblestones; neutral; gradual wavy boundary.

B3—28 to 36 inches; reddish brown (5YR 4/3) silty clay; moderate medium prismatic structure; firm; few fine roots; about 8 percent by volume of gravel; about 5 percent by volume of cobblestones; common fine pink (5YR 7/4) lime segregations; slight effervescence; mildly alkaline; abrupt wavy boundary.

IIC—36 to 60 inches; yellowish brown (10YR 5/4) gravelly fine sandy loam; common medium distinct yellowish brown (10YR 5/6) mottles in upper part; massive; very friable; about 25 percent by volume of gravel; about 10 percent by volume of stones; strong effervescence; moderately alkaline.

Thickness of the solum and depth to the coarser textured underlying till range from 24 to 40 inches. Thickness of the upper silty mantle is less than 18 inches. Reaction in the solum ranges from medium acid to neutral in the upper part and from slightly acid to mildly alkaline in the lower part. Free carbonates are just below the solum or in the B3 horizon. The solum is 2 to 10 percent by volume dolomite gravel.

The Ap horizon has 10YR or 7.5YR hue, value of 3 or 4, and chroma of 2 or 3. The B horizon commonly is clay or silty clay. Some pedons have subhorizons of silty clay loam or clay loam. The IIC horizon is 15 to 50 percent by volume dolomite gravel. It has a calcium carbonate equivalent between 40 and 60 percent and is mildly or moderately alkaline.

Ossian series

The Ossian series consists of poorly drained, moderately permeable soils formed in thick deposits of silty material. These soils are in depressional areas and upland drainageways. Slopes are 0 to 2 percent.

Ossian soils formed in the same kind of material as the nearby Atterberry soils. They are near Keowns and Lamartine soils. Atterberry soils are somewhat poorly drained. Keowns soils, in similar landscape positions, have carbonates at a depth of 12 to 24 inches. They are coarse-loamy. The somewhat poorly drained Lamartine soils are on adjacent terraces where the silty material overlies glacial till at depths of 20 to 36 inches.

Typical pedon in an area of Ossian silt loam, 725 feet east and 140 feet north of southwest corner NE1/4 sec. 28, T. 17 N., R. 14 E.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; very friable; common fine roots; neutral; abrupt smooth boundary.

A12—8 to 12 inches; black (10YR 2/1) silt loam, dark grayish brown (10YR 4/2) dry; moderate coarse subangular blocky structure; friable; few fine roots; neutral; abrupt smooth boundary.

B2g—12 to 20 inches; olive gray (5Y 5/2) silt loam; few fine prominent light brown (7.5YR 6/4) and strong brown (7.5YR 5/6) mottles; weak fine subangular blocky structure; friable; few fine roots; faces of some peds are gray (5Y 5/1); neutral; clear wavy boundary.

B3g—20 to 30 inches; olive gray (5Y 5/2) silt loam; many fine prominent strong brown (7.5YR 5/6) mottles; moderate coarse prismatic structure; friable; few fine roots; faces of prisms are dark gray (5Y 4/1) and gray (5Y 5/1); neutral; gradual wavy boundary.

C—30 to 60 inches; olive gray (5Y 5/2) silt loam; common fine prominent brown (7.5YR 5/4) and many fine prominent yellowish red (5YR 4/6) mottles; massive; friable; faces of pores are greenish gray (5G 5/1); mildly alkaline.

Thickness of the solum ranges from 30 to 40 inches. The solum commonly is neutral, but in some pedons it is mildly alkaline. Free carbonates commonly are at depths of 40 to 60 inches.

The A horizon has 10YR or N hue and chroma or 0 to 1. It is 10 to 15 inches thick. The B horizon has 5Y or 2.5Y hue. It commonly is silt loam, but in some pedons it is silty clay loam. The C horizon commonly is silt loam, but in some pedons it has a thin stratum of very fine sand below a depth of 40 inches.

Palms series

The Palms series consists of very poorly drained soils that are moderately rapidly permeable in the upper part and moderately or moderately slowly permeable in the lower part. These soils formed in deposits of organic material over loamy mineral deposits that average less than 35 percent clay. They are in depressions and in low areas adjacent to drainageways and lakes. Slopes are 0 to 2 percent.

Palms soils are similar to Adrian, Edwards, Houghton, and Willette soils. All formed in deposits of organic material. Adrian soils are underlain by sandy material at depths of 16 to 51 inches. Edwards soils are underlain by marl at depths of 16 to 51 inches. Houghton soils have organic material extending to depths of more than 51 inches. Willette soils have clayey or loamy material at

depths of 16 to 51 inches that averages more than 35 percent clay.

Typical pedon in an area of Palms muck, 780 feet west and 300 feet south of northeast corner NE1/4NW1/4 sec. 10, T. 17 N., R. 14 E.

Oa1—0 to 3 inches; very dark brown (10YR 2/2, broken face), black (10YR 2/1, rubbed and pressed) sapric material; about 30 percent fiber, less than 10 percent rubbed; massive; very friable; primarily herbaceous fibers; sodium pyrophosphate pale brown (10YR 6/3); slightly acid; abrupt smooth boundary.

Oa2—3 to 25 inches; black (N 2/0, broken face, rubbed and pressed) sapric material; about 5 percent fiber, less than 2 percent rubbed; massive; very friable; primarily herbaceous fibers; sodium pyrophosphate dark brown (10YR 4/3); about 5 percent by volume of mineral material; slightly acid; abrupt smooth boundary.

IIC—25 to 60 inches; grayish brown (2.5Y 5/2) silt loam; common medium distinct light olive brown (2.5Y 5/4) mottles concentrated along vertical pores; massive; friable; few thin strata of sand; slight effervescence; mildly alkaline.

The depth to the loamy IIC horizon ranges from 16 to 51 inches. The organic material is primarily herbaceous, but some pedons are as much as 10 percent by volume woody fragments. The organic material ranges from medium acid to mildly alkaline.

The surface tier commonly has 10YR hue or is neutral and has chroma of 0 through 2 on broken face and rubbed. The organic part of the subsurface and bottom tiers has 10YR, 7.5YR, 5YR, and N hue, value of 2 or 3, and chroma of 0 through 2. Some pedons have thin layers of hemic material in these tiers. In some pedons the organic layer just above the IIC horizon is as much as 20 percent by volume mineral material. The IIC horizon is silt loam, loam, or silt and fine sand that is stratified. It ranges from slightly acid to moderately alkaline.

Plano series

The Plano series consists of well drained, moderately permeable soils formed in silty material and the underlying loamy glacial till. These soils are on broad till plains. Slopes are 2 to 6 percent.

Plano soils formed in the same kind of material as McHenry and St. Charles soils. McHenry soils have a thinner silty mantle and solum and are fine-loamy. McHenry and St. Charles soils have an ochric epipedon.

Typical pedon in an area of Plano silt loam, 2 to 6 percent slopes, 260 feet south and 220 feet west of northeast corner NW1/4 sec. 29, T. 17 N., R. 14 E.

Ap—0 to 8 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak very fine subangular blocky structure; very friable; many fine roots; slightly acid; abrupt smooth boundary.

A12—8 to 12 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; many fine roots; slightly acid; abrupt wavy boundary.

A13—12 to 15 inches; very dark grayish brown (10YR 3/2) silt loam, grayish brown (10YR 5/2) dry; weak fine subangular blocky structure; friable; many fine roots; medium acid; clear wavy boundary.

B1—15 to 21 inches; brown (10YR 4/3) silt loam; weak fine subangular blocky structure; friable; many fine roots; common black (10YR 2/1) worm casts; medium acid; gradual wavy boundary.

B2t—21 to 38 inches; dark brown (10YR 4/3) silty clay loam; moderate fine subangular blocky structure; friable; common fine roots; many thin clay films on faces of peds; medium acid; clear wavy boundary.

B31t—38 to 47 inches; dark brown (10YR 4/3) silt loam; moderate medium prismatic structure; friable; few fine roots; common thin clay films on faces of peds; medium acid; abrupt wavy boundary.

IIB32t—47 to 55 inches; dark brown (7.5YR 4/4) sandy loam; weak medium subangular blocky structure; friable; few fine roots; many thin clay bridges between mineral grains; about 10 percent by volume of gravel; slightly acid; abrupt wavy boundary.

IIC—55 to 60 inches; brown (10YR 5/3) sandy loam; weak thin platy structure; very friable; about 10 percent by volume of gravel; strong effervescence; moderately alkaline.

Thickness of the solum ranges from 44 to 65 inches, the same as the depth to carbonates. Thickness of the upper silty material ranges from 40 to 60 inches. The solum ranges from medium acid to neutral. The A horizon is 10 to 16 inches thick. The lower part of the solum is as much as 10 percent by volume gravel.

The A horizon has value of 2 or 3 and chroma of 1 or 2. The Bt horizon in the upper silty material has chroma of 3 or 4. The IIBt horizon commonly is sandy loam or sandy clay loam but ranges to loam. The IIC horizon is 5 to 20 percent by volume gravel.

Poy series

The Poy series consists of poorly drained soils that are slowly or very slowly permeable in the upper part and rapidly permeable in the lower part. These soils formed in clayey water-laid sediment over sandy material. They are in slight depressions in lake basins and stream terraces. Slopes are 0 to 2 percent.

Poy soils formed in the same kind of material as the nearby Borth and Zittau soils. The moderately well drained Borth soils and somewhat poorly drained Zittau soils, in slightly higher landscape positions, do not have low chroma matrix colors just below the A horizon.

Typical pedon in an area of Poy silty clay loam 30 feet west and 350 feet south of northeast corner sec. 3, T. 20 N., R. 14 E.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; moderate fine granular structure; firm; common fine roots; neutral; abrupt smooth boundary.

B1g—9 to 12 inches; very dark gray (5Y 3/1) clay, olive gray (5Y 5/2) dry; common fine prominent dark brown (7.5YR 4/4) mottles; strong fine angular blocky structure; firm; common fine roots; neutral; abrupt wavy boundary.

B2g—12 to 16 inches; grayish brown (2.5Y 5/2) clay; common fine prominent reddish brown (5YR 5/3) and many medium prominent strong brown (7.5YR 5/6) mottles; strong very fine angular blocky structure; firm; common fine roots; neutral; abrupt wavy boundary.

B31—16 to 25 inches; reddish brown (5YR 4/3) clay; many medium prominent grayish brown (2.5Y 5/2) and many medium faint brown (7.5YR 4/4) mottles; moderate fine prismatic structure parting to moderate fine angular blocky; firm; common fine roots; mildly alkaline; clear wavy boundary.

B32—25 to 34 inches; reddish brown (5YR 5/3) clay; many coarse prominent greenish gray (5GY 6/1) and few medium prominent olive brown (2.5Y 4/4) mottles; moderate medium prismatic structure; firm; few fine roots; faces of prisms totally gleyed; violent effervescence with many pink (5YR 7/3) lime segregations; moderately alkaline; abrupt smooth boundary.

IIC—34 to 60 inches; brown (10YR 5/3) fine and medium sand; single grained; loose; mildly alkaline.

Thickness of the solum and depth to the underlying sand range from 20 to 40 inches. The solum ranges from slightly acid to moderately alkaline.

The Ap horizon has value of 2 or 3 and chroma of 0 or 1. The B horizon commonly is clay, but some pedons have subhorizons of silty clay. The B1g horizon has value of 3 or 4. The B2g horizon has 2.5Y or 5Y hue, value of 4 or 5, and chroma of 1 or 2. The IIC horizon is medium or fine sand. It is neutral or mildly alkaline.

Poygan series

The Poygan series consists of poorly drained, slowly permeable soils formed in clayey or loamy glacial till. The glacial till underlies a thin mantle of silty material. These soils are in valley lowlands and upland drainageways. Slopes are 0 to 2 percent.

Poygan soils formed in the same kind of material as the nearby Manawa and Kewaunee soils. The somewhat poorly drained Manawa soils and well drained and moderately well drained Kewaunee soils, in slightly higher landscape positions, do not have matrix colors with chroma of 2 or less in the upper part of the B horizon.

Typical pedon in an area of Poygan silty clay loam, 160 feet north and 60 feet east of southwest corner SE1/4 sec. 35, T. 17 N., R. 16 E.

Ap—0 to 9 inches; black (10YR 2/1) silty clay loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; friable; common fine roots; neutral; abrupt smooth boundary.

B11g—9 to 11 inches; very dark gray (5Y 3/1) silty clay loam, dark gray (5Y 4/1) dry; common fine prominent dark brown (7.5YR 4/4) and common coarse faint dark gray (5Y 4/1) mottles; moderate very fine subangular blocky structure; friable; common fine roots; neutral; abrupt irregular boundary.

B12g—11 to 15 inches; dark gray (5Y 4/1) silty clay; many fine prominent dark yellowish brown (10YR 4/4) mottles; strong fine angular blocky structure; firm; common fine roots; estimated 3 percent by volume of gravel; neutral; abrupt irregular boundary.

B2g—15 to 21 inches; olive gray (5Y 5/2) silty clay; many medium prominent dark brown (7.5YR 4/4) mottles; strong fine angular blocky structure; firm; common fine roots; estimated 5 percent by volume of gravel; neutral; clear wavy boundary.

B3—21 to 33 inches; reddish brown (5YR 5/3) silty clay; many medium prominent gray (5Y 5/1) and many medium faint dark brown (7.5YR 4/4) mottles; moderate fine prismatic structure parting to moderate fine angular blocky; firm; few fine roots; estimated 10 percent by volume of gravel; slight effervescence in lower 7 inches; mildly alkaline; gradual wavy boundary.

C—33 to 60 inches; reddish brown (5YR 4/3) silty clay; common fine prominent gray (5Y 5/1) mottles; massive; firm; estimated 5 percent by volume of gravel; strong effervescence; moderately alkaline.

Thickness of the solum ranges from 20 to 36 inches. Some pedons have an upper mantle of silty material less than 20 inches thick. The solum ranges from slightly acid to mildly alkaline. Free carbonates are just below the solum or in the B3 horizon. The solum is as much as 10 percent by volume gravel.

The Ap horizon has value of 2 or 3 and chroma of 0 or 1. The B horizon commonly is silty clay loam, silty clay, or clay, but some pedons have subhorizons of clay loam. The B1g horizon has 10YR, 2.5Y or 5Y hue, value of 3 or 4. The B2g horizon has 10YR, 2.5Y, or 5Y hue, value of 4 through 6, and chroma of 1 or 2. The B3 and C horizons have value of 4 or 5 and chroma of 3 or 4. The C horizon is clay, silty clay, clay loam, or silty clay loam. It is mildly or moderately alkaline. It is as much as 10 percent by volume gravel.

Puchyan series

The Puchyan series consists of moderately well drained soils that are moderately rapidly or rapidly permeable in the upper part and moderately permeable in the lower part. These soils formed in stratified parent material. The upper layer is sandy, the middle layer is silty or loamy, and the lower layer is loamy glacial till.

These soils are on valley terraces and till moraines. Slopes are 2 to 6 percent.

Puchyan soils are similar to Grellton and Tustin soils. Grellton soils have similar material in the lower part of the solum, but the upper part of the solum is loamy. Tustin soils have similar upper horizons formed in sandy material, but the lower part of the solum and C horizon contain more clay.

Typical pedon in an area of Puchyan loamy fine sand, 2 to 6 percent slopes, 230 feet east and 160 feet south of northwest corner sec. 19, T. 17 N., R. 14 E.

Ap—0 to 9 inches; dark brown (10YR 4/3) loamy fine sand; very weak medium subangular blocky structure; very friable; many fine roots; slightly acid; abrupt smooth boundary.

A2—9 to 21 inches; yellowish brown (10YR 5/4) fine sand; very weak coarse subangular blocky structure; very friable; common fine roots; slightly acid; abrupt wavy boundary.

IIB1t—21 to 27 inches; brown (7.5YR 4/4) fine sandy loam; few fine distinct strong brown (7.5YR 5/6) mottles; weak medium subangular blocky structure; friable; common fine roots; common thin clay bridges between mineral grains; medium acid; abrupt wavy boundary.

B21t—27 to 31 inches; yellowish brown (10YR 5/4) loam; common fine distinct strong brown (7.5YR 5/6) mottles; moderate medium subangular blocky structure; friable; common fine roots; many thin clay films on faces of peds; medium acid; clear wavy boundary.

IIIB22t—31 to 39 inches; light olive brown (2.5Y 5/4) silt loam; many medium distinct olive gray (5Y 5/2) mottles and common fine distinct yellowish brown (10YR 5/6) and strong brown (7.5YR 5/6) mottles; moderate fine prismatic structure parting to moderate fine subangular blocky; friable; few fine roots; common thin clay films on faces of peds; slightly acid; clear wavy boundary.

IIIB3t—39 to 57 inches; dark yellowish brown (10YR 4/4) silt loam; common fine distinct grayish brown (10YR 5/2) and many medium faint dark brown (7.5YR 4/4) mottles; moderate medium prismatic structure; friable; few fine roots; few thin clay films on faces of peds; slightly acid; clear wavy boundary.

IIIC—57 to 60 inches; olive brown (2.5Y 4/4) silt loam; few medium distinct yellowish brown (10YR 5/6) mottles; massive; friable; few fine roots; neutral.

Thickness of the solum ranges from 40 to 60 inches. The solum formed in two or three layers of parent material. The sandy upper layer is 20 to 40 inches thick. The silty or loamy middle layer is more than 15 inches thick.

The Ap horizon has value of 4 or 5 and chroma of 2 or 3. The A2 horizon is fine sand or loamy fine sand. The Ap, A2, and IIB horizons are medium or slightly acid. The IIIB3t horizon is slightly acid or neutral. In some pedons the lower part of the Bt horizon formed in glacial till. In some places the C horizon is silt loam. In other places it is sandy loam or fine sandy loam glacial till at a depth of 45 to 60 inches. The glacial till is about 10 to 20 percent by volume gravel.

Ritchey series

The Ritchey series consists of well drained, moderately permeable soils formed in loamy material over limestone (fig. 9). These soils are on bedrock-controlled plateaus and valley sides. Slopes are 2 to 30 percent.

Ritchey soils are near Knowles and Whalan soils. Knowles and Whalan soils, in similar landscape positions, overlie limestone bedrock at depths of 20 to 40 inches. Knowles soils are fine-silty. Whalan soils are fine-loamy.

Typical pedon in an area of Ritchey silt loam, 2 to 6 percent slopes, 370 feet north and 525 feet west of southeast corner NW1/4SW1/4 sec. 10, T. 17 N., R. 14 E.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam; weak medium subangular blocky structure; very friable; common fine roots; neutral; abrupt smooth boundary.

B1t—8 to 10 inches; dark yellowish brown (10YR 4/4) loam; weak very fine subangular blocky structure; friable; common fine roots; few thin clay films on faces of peds; about 4 percent by volume of gravel; common dark grayish brown (10YR 4/2) worm casts; neutral; abrupt wavy boundary.

B21t—10 to 15 inches; dark brown (7.5YR 4/4) clay loam; moderate very fine subangular blocky structure; friable; few fine roots; many thin clay films on faces of peds; about 8 percent by volume of gravel; neutral; clear wavy boundary.

B22t—15 to 17 inches; dark brown (7.5YR 4/4) sandy clay loam; moderate fine subangular blocky structure; friable; few fine roots; many moderately thick clay films on faces of peds; about 8 percent by volume of gravel; neutral; abrupt wavy boundary.

R—17 inches; bedded limestone bedrock.

Thickness of the solum and depth to limestone bedrock range from 10 to 20 inches. Reaction in the solum ranges from slightly acid to mildly alkaline. The solum is 2 to 10 percent by volume gravel.

The Ap horizon has hue of 10YR or 7.5YR, value of 3 or 4, and chroma of 2 or 3. Some pedons have a thin A1 or A2 horizon with texture similar to that of the Ap horizon. The B2t horizon has 5YR or 7.5YR hue and value and chroma of 3 or 4.

St. Charles series

The St. Charles series consists of well drained, moderately permeable soils formed in silty material and the

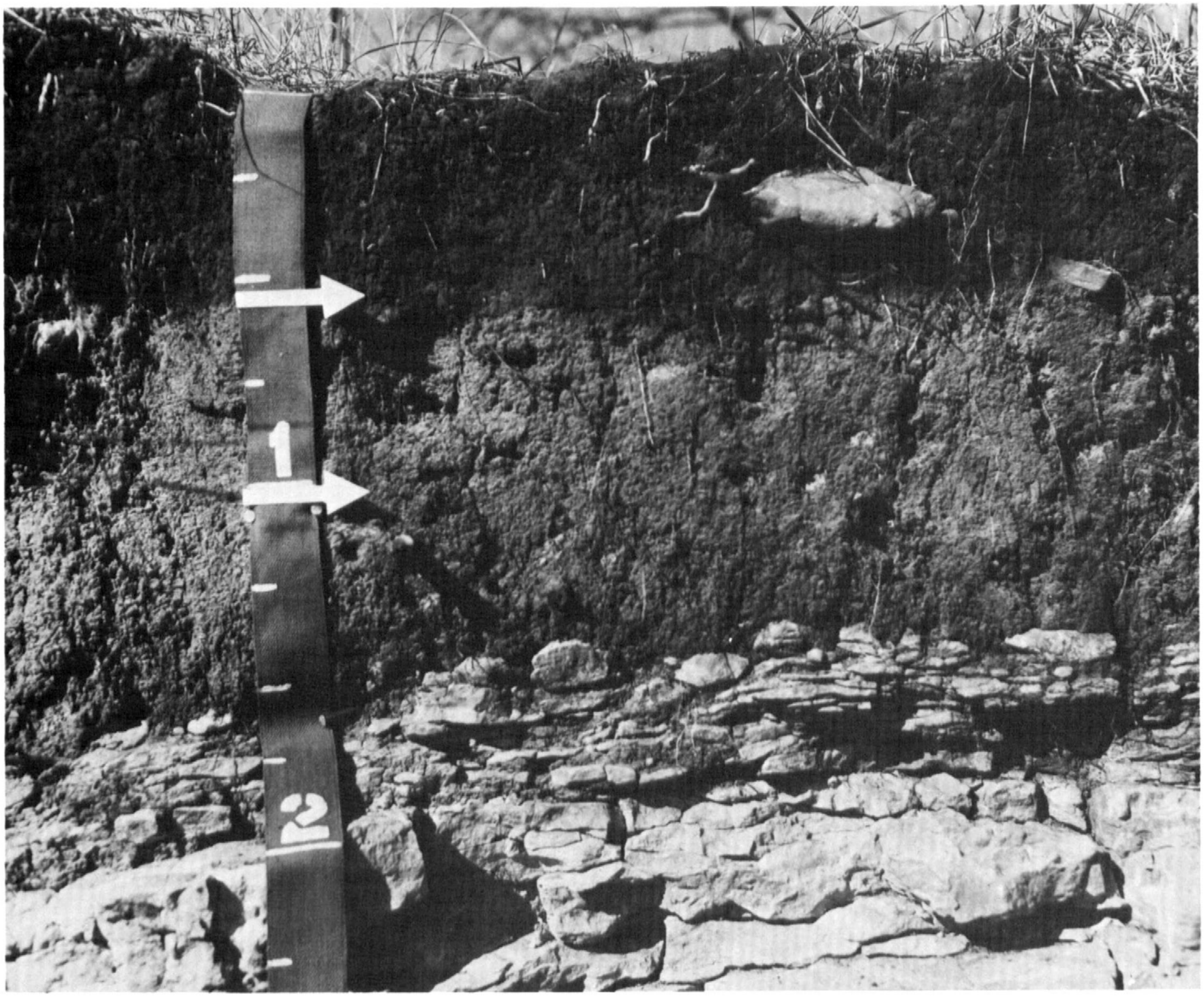


Figure 9.—Profile of Ritchey silt loam. Shallowness over limestone restricts many uses of this soil. The scale is in feet.

underlying loamy glacial till. These soils are on till plains between drumlin ridges and moraines and on high valley terraces. Slopes are 2 to 6 percent.

St. Charles soils formed in the same kind of material as Plano soils and the nearby Atterberry and Knowles soils. The somewhat poorly drained Atterberry soils, in lower positions, are mottled throughout the B horizon and do not have the underlying till within a depth of 60 inches. Knowles soils, in similar landscape positions, overlie limestone bedrock at a depth of 20 to 40 inches. Plano soils have a mollic epipedon.

Typical pedon in an area of St. Charles silt loam, 2 to 6 percent slopes, 120 feet west and 925 feet south of northeast corner SW1/4 sec. 28, T. 17 N., R. 14 E.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) silt loam; weak medium subangular blocky structure; very friable; common fine roots; neutral; abrupt smooth boundary.

A2—9 to 12 inches; brown (10YR 5/3) silt loam; weak thin platy structure; very friable; common fine roots; common dark grayish brown (10YR 4/2) worm casts; neutral; abrupt smooth boundary.

B1—12 to 16 inches; yellowish brown (10YR 5/4) silt loam; weak fine subangular blocky structure; very friable; common fine roots; neutral; clear wavy boundary.

B21t—16 to 25 inches; dark yellowish brown (10YR 4/4) silt loam; moderate fine subangular blocky structure; friable; common fine roots; common thin dark brown (7.5YR 4/4) clay films on faces of peds; strongly acid; clear wavy boundary.

B22t—25 to 34 inches; dark yellowish brown (10YR 4/4) silt loam; moderate medium subangular blocky structure; friable; few fine roots; common thin dark brown (7.5YR 4/4) clay films on faces of peds; medium acid; gradual wavy boundary.

B23t—34 to 46 inches; dark yellowish brown (10YR 4/4) silty clay loam; moderate medium prismatic structure; friable; few fine roots; common thin dark brown (7.5YR 4/4) clay films on faces of peds; medium acid; abrupt wavy boundary.

IIB24t—46 to 53 inches; dark brown (7.5YR 4/4) sandy clay loam; moderate fine subangular blocky structure; friable; few fine roots; few thin dark brown (7.5YR 3/2) clay films on faces of peds; continuous moderately thick clay bridges between mineral grains; about 5 percent by volume gravel; few dolomite cobblestones; neutral; clear wavy boundary.

IIB3t—53 to 56 inches; dark brown (7.5YR 4/4) sandy loam; weak medium subangular blocky structure; very friable; few fine roots; many thin dark brown (7.5YR 3/2) clay bridges between mineral grains; about 10 percent by volume of gravel; few dolomite cobblestones; neutral; abrupt wavy boundary.

IIC—56 to 60 inches; brown (7.5YR 5/4) fine sandy loam; weak thin platy structure; very friable; about 10 percent by volume of gravel; slight effervescence; moderately alkaline (calcium carbonate equivalent 26 percent).

Thickness of the solum ranges from 44 to 65 inches, the same as the depth to carbonates. Thickness of the upper silty material ranges from 40 to 60 inches. The lower part of the solum is as much as 10 percent by volume gravel.

The Bt horizon in the upper silty material has chroma of 3 or 4. It ranges from slightly to strongly acid below the influence of agricultural lime. The IIBt horizon is sandy clay loam, loam, or sandy loam. It is slightly acid or neutral. The IIC horizon is sandy loam or fine sandy loam, but in some pedons it is gravelly.

Tustin series

The Tustin series consists of well drained soils that are rapidly permeable in the upper part and slowly permeable in the lower part. These soils formed in sandy deposits and the underlying loamy or clayey glacial till. They are on till plains. Slopes are 2 to 6 percent.

Tustin soils are similar to Nebago, Oakville, and Puchyan soils. They are near Kewaunee soils. The somewhat poorly drained Nebago soils formed in similar material but have low chroma mottles within a depth of 24 inches. Oakville soils formed in a thicker sandy deposit and do not have loamy or clayey layers within a depth of 60 inches. Puchyan soils formed partly in similar sandy material but have an argillic horizon that is less than 18 percent clay. Kewaunee soils are in similar landscape positions where the upper sandy deposit is less than 18 inches thick.

Typical pedon in an area of Tustin fine sand, 2 to 6 percent slopes, 270 feet west and 920 feet south of northeast corner SW1/4 sec. 13, T. 18 N., R. 15 E.

Ap—0 to 8 inches; dark brown (10YR 3/3) fine sand; weak medium subangular blocky structure; very friable; many fine roots; slightly acid; abrupt smooth boundary.

B1—8 to 26 inches; dark yellowish brown (10YR 4/4) fine sand; weak coarse subangular blocky structure; very friable; common fine roots; slightly acid; clear wavy boundary.

IIB21t—26 to 30 inches; dark brown (7.5YR 4/4) sandy clay loam; moderate fine subangular blocky structure; friable; common fine roots; about 2 percent by volume of gravel; common thin clay films on faces of peds; medium acid; clear wavy boundary.

IIB22t—30 to 39 inches; reddish brown (5YR 4/3) clay; strong fine angular blocky structure; firm; few fine roots; about 4 percent by volume of gravel; many thin clay films on faces of peds; medium acid; clear wavy boundary.

IIB23t—39 to 46 inches; reddish brown (5YR 4/3) clay; moderate coarse prismatic structure parting to moderate medium subangular blocky; firm; few fine roots; about 4 percent by volume of gravel; common thin clay films on faces of peds; slightly acid; clear wavy boundary.

IIC—46 to 60 inches; reddish brown (5YR 4/4) clay loam; massive; firm; about 4 percent by volume of gravel; slight effervescence; mildly alkaline.

Thickness of the solum commonly is 40 to 50 inches. Thickness of the upper sandy material ranges from 20 to 40 inches. The sandy upper part of the solum is neutral to strongly acid, and the clayey or loamy lower part is medium acid to mildly alkaline. The clayey or loamy glacial till is 2 to 10 percent by volume dolomite gravel.

The Ap horizon has value of 3 or 4. The B1 horizon commonly is fine sand, but in some places it is loamy fine sand. The IIB21t horizon is fine sandy loam or sandy clay loam. The IIB22t and IIB23t horizons are clay, silty clay, silty clay loam, or clay loam. The IIC horizon is clay, silty clay, silty clay loam, or clay loam. It is mildly or moderately alkaline.

Wauseon series

The Wauseon series consists of poorly drained soils that are moderately permeable in the upper part and

slowly or moderately slowly permeable in the lower part. These soils formed in silty and loamy water-laid sediment over glacial till. They are in swales and drainageways in the uplands. Slopes are 0 to 2 percent. The Wauseon soils in this survey area are outside the defined limits for the series because they have silt loam in the solum. This difference, however, does not alter the use or behavior of the soils.

Wauseon soils formed in the same kind of material as Keowns, Korobago, and Yahara soils. The poorly drained Keowns soils and somewhat poorly drained Yahara soils are underlain by stratified lacustrine deposits. The somewhat poorly drained Korobago soils do not have horizons dominated by chroma of 2 or less in the upper part of the B horizon.

Typical pedon in an area of Wauseon silt loam, 150 feet west and 800 feet north of southeast corner NW1/4 sec. 27, T. 20 N., R. 16 E.

Ap—0 to 9 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; moderate fine granular structure; very friable; many fine roots; high content of very fine sand; neutral; abrupt smooth boundary.

A12—9 to 13 inches; black (10YR 2/1) silt loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; very friable; many fine roots; high content of very fine sand; neutral; abrupt smooth boundary.

B21g—13 to 17 inches; olive gray (5Y 5/2) silt loam; common fine prominent yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; very friable; common fine roots; high content of very fine sand; few thin discontinuous lenses of gray (5Y 5/1) silt loam; few black (10YR 2/1) worm casts; neutral; clear wavy boundary.

B22g—17 to 23 inches; grayish brown (2.5Y 5/2) silt loam; many fine prominent yellowish brown (10YR 5/6) mottles; weak medium prismatic structure parting to weak thin platy; very friable; common fine roots; high content of very fine sand; few black (10YR 2/1) worm casts; mildly alkaline; abrupt wavy boundary.

IIB23g—23 to 28 inches; olive gray (5Y 5/2) fine sandy loam; many fine prominent strong brown (7.5YR 5/6) and reddish brown (5YR 5/3) mottles; weak medium prismatic structure parting to moderate thin platy; very friable; common fine roots; slight effervescence; mildly alkaline; abrupt wavy boundary.

IIB3g—28 to 35 inches; light olive gray (5Y 6/2) very fine sandy loam; many fine prominent brown (7.5YR 4/4) and reddish brown (5YR 5/3) mottles; weak medium prismatic structure; very friable; common fine roots; massive between faces of prisms; slight effervescence; mildly alkaline; abrupt wavy boundary.

IIC—35 to 60 inches; reddish brown (5YR 4/4) silty clay loam; many medium prominent greenish gray (5GY 6/1) mottles and many fine prominent yellowish red (5YR 4/8) mottles; massive; firm; few cobblestones; estimated 2 percent by volume of gravel; slight effervescence; moderately alkaline.

Thickness of the solum ranges from 20 to 36 inches. Thickness of the coarser textured water-laid sediment is 20 to 40 inches. The solum is neutral or mildly alkaline. Free carbonates are at depths of 12 to 32 inches. The mollic epipedon is 8 to 14 inches thick.

The Ap horizon has 10YR or N hue, value of 2 or 3, and chroma of 0 through 2. Some pedons have no A12 horizon. The Bg horizon has 10YR, 2.5Y, or 5Y hue, value of 4 through 6, and chroma of 1 or 2. It contains strata of silt, very fine sand, and fine sand. The IIC horizon has value of 3 through 5 and chroma of 3 or 4. It is clay, silty clay, silty clay loam, or clay loam. It is as much as 20 percent by volume gravel. It is mildly or moderately alkaline.

Whalan series

The Whalan series consists of well drained, moderately permeable soils formed partly in a thin mantle of silty or sandy material and in the underlying loamy glacial till, which is underlain by limestone bedrock. These soils are on valley sides and broad till plains. Slopes are 2 to 12 percent.

Whalan soils formed in the same kind of material as the nearby Hortonville and Kidder soils. They are similar to Knowles soils. Hortonville and Kidder soils are in similar landscape positions but are underlain by glacial till. Knowles soils are underlain by limestone bedrock at similar depths but have less sand and more silt in the control section.

Typical pedon in an area of Whalan silt loam, 2 to 6 percent slopes, 150 feet west and 800 feet south of northeast corner SE1/4 sec. 5, T. 20 N., R. 17 E.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) silt loam; weak fine subangular blocky structure; friable; common fine roots; neutral; abrupt smooth boundary.

B21t—9 to 24 inches; dark brown (7.5YR 4/4) clay loam; moderate medium subangular blocky structure; friable; common fine roots; continuous thin clay films on faces of peds; about 6 percent by volume of gravel; medium acid; clear wavy boundary.

B22t—24 to 35 inches; reddish brown (5YR 4/4) clay loam; weak medium subangular blocky structure; firm; common fine roots; common thin clay films on faces of peds; about 10 percent by volume of gravel; slightly acid; abrupt wavy boundary.

R—35 inches; bedded limestone bedrock.

Thickness of the solum and depth to limestone bedrock range from 20 to 40 inches. Thickness of the upper silty or sandy material is less than 20 inches.

The A horizon is silt loam or loamy fine sand. It ranges from medium acid to neutral. The Ap horizon has value of 3 or 4. Some pedons have an A1 horizon 2 to 5 inches thick and a thin A2 horizon. Some pedons have a B1 horizon that is silt loam or loamy fine sand. The B2t

horizon has hue of 7.5YR or 5YR and value and chroma of 3 or 4. It is loam or clay loam and ranges from medium acid to mildly alkaline. It is as much as 10 percent by volume gravel.

Willette series

The Willette series consists of very poorly drained soils that are moderately rapidly permeable in the upper part and slowly permeable in the lower part. These soils formed in deposits of organic material over clayey or loamy deposits. They are in depressional areas and in low areas adjacent to drainageways and lakes. Slopes are 0 to 2 percent.

Willette soils are similar to Adrian, Edwards, Houghton, and Palms soils. All formed in deposits of organic material. Adrian soils are underlain by sandy material at depths of 16 to 51 inches. Edwards soils are underlain by marl at depths of 16 to 51 inches. Houghton soils have organic material extending to depths greater than 51 inches. Palms soils have loamy material at depths of 16 to 51 inches that averages less than 35 percent clay.

Typical pedon in an area of Willette muck, 790 feet east and 800 feet north of southwest corner NW1/4 sec. 11, T. 20 N., R. 14 E.

Oa1—0 to 8 inches; black (10YR 2/1, broken face and rubbed), very dark brown (10YR 2/2, pressed) sapric material; about 3 percent fiber, trace rubbed; weak fine granular structure; very friable; primarily herbaceous fibers; sodium pyrophosphate pale brown (10YR 5/3); neutral; abrupt smooth boundary.

Oa2—8 to 26 inches; black (5YR 2/1, broken face), black (10YR 2/1, rubbed), very dark brown (10YR 2/2, pressed) sapric material; about 3 percent fiber, trace rubbed; moderate fine subangular blocky structure; very friable; primarily herbaceous fibers; sodium pyrophosphate brown (10YR 5/3); slightly acid; abrupt smooth boundary.

IIC1g—26 to 31 inches; very dark gray (mixed N 3/0 and 5Y 3/1) silty clay; many fine prominent dark brown (7.5YR 4/4) mottles; weak fine prismatic structure; firm; neutral; abrupt wavy boundary.

IIC2g—31 to 35 inches; gray (5Y 5/1) silty clay; common fine prominent dark brown (7.5YR 4/4) and dark reddish brown (2.5YR 3/4) mottles; massive; firm; mildly alkaline; clear wavy boundary.

IIC3—35 to 60 inches; reddish brown (5YR 5/3) clay; many coarse prominent greenish gray (5GY 5/1) mottles; moderate thin platy structure; firm; slight effervescence; moderately alkaline.

The depth to the clayey IIC horizon ranges from 16 to 51 inches. The organic material is primarily herbaceous, but some pedons are as much as 10 percent by volume woody fragments. The organic material ranges from medium acid to mildly alkaline.

The surface tier commonly has 10YR hue or is neutral and has chroma of 0 through 2 on broken face and rubbed. The organic part of the subsurface and bottom tiers has 10YR, 7.5YR, 5YR, or N hue, value of 2 or 3, and chroma of 0 through 2. Some pedons have thin layers of hemic material in these tiers. In some pedons the organic material layer just above the IIC horizon is as much as 20 percent by volume mineral material. The IIC horizon is silty clay loam, silty clay, or clay.

Winneconne series

The Winneconne series consists of moderately well drained, slowly or very slowly permeable soils formed in clayey water-laid sediment. These soils are in glacial lake basins and on lake terraces and stream terraces. Slopes are 1 to 4 percent.

Winneconne soils have a Bt horizon similar to that of Borth, Kewaunee, and Neenah soils. They are near Neenah soils. Borth soils are underlain by sand at depths of 20 to 40 inches. Kewaunee soils formed in glacial till and average less than 60 percent clay in the argillic horizon. The somewhat poorly drained Neenah soils, in slightly lower landscape positions, have low chroma mottles within the upper 10 inches of the argillic horizon.

Typical pedon in an area of Winneconne silty clay loam, 1 to 4 percent slopes, 525 feet north and 20 feet east of southwest corner SE1/4 sec. 5, T. 19 N., R. 17 E.

Ap—0 to 7 inches; very dark brown (10YR 2/2) silty clay loam, dark brown (7.5YR 4/2) dry; weak medium subangular blocky structure; firm; common fine roots; mildly alkaline; abrupt smooth boundary.

B1t—7 to 9 inches; reddish brown (5YR 4/3) clay; weak fine subangular blocky structure; firm; common fine roots; common thin clay films on faces of peds; common very dark brown (10YR 2/2) worm casts; neutral; clear wavy boundary.

B2t—9 to 17 inches; reddish brown (5YR 4/3) clay; moderate and strong fine angular blocky structure; firm; common fine roots; many thin clay films on faces of peds; neutral; clear wavy boundary.

B3t—17 to 22 inches; reddish brown (5YR 4/3) clay; common fine prominent olive gray (5Y 5/2) and yellowish red (5YR 4/6) mottles; weak fine prismatic structure parting to moderate very fine angular blocky; firm; few fine roots; common thin clay films on faces of peds; strong effervescence; mildly alkaline; clear wavy boundary.

C—22 to 60 inches; reddish brown (5YR 5/3) clay; many medium prominent greenish gray (5GY 6/1) mottles; moderate thick platy structure; firm; many light reddish brown (5YR 6/3) lime segregations; violent effervescence; moderately alkaline.

Thickness of the solum ranges from 18 to 26 inches, commonly somewhat more than the depth to free carbonates. The solum commonly is neutral or mildly alka-

line, but in some pedons it is medium or slightly acid in the upper part.

The Ap horizon has 7.5YR or 10YR hue, value of 2 or 3, and chroma of 1 or 2. The Bt horizon commonly is clay, but some pedons have subhorizons of silty clay. The C horizon is mildly or moderately alkaline. Some pedons have a few thin strata of sand in the C horizon.

Yahara series

The Yahara series consists of somewhat poorly drained, moderately permeable soils formed in silty and loamy water-laid sediment. These soils are on lake terraces and valley terraces and in upland drainageways. Slopes are 0 to 3 percent.

Yahara soils formed in the same kind of material as Keowns, Korobago, and Wauseon soils. The poorly drained Keowns soils have a B horizon dominated by chroma of 2 or less. The somewhat poorly drained Korobago soils and poorly drained Wauseon soils have glacial deposits at depths of 20 to 40 inches that are more than 35 percent clay.

Typical pedon in an area of Yahara silt loam, 0 to 3 percent slopes, 25 feet west and 800 feet north of southeast corner SW1/4 sec. 25, T. 19 N., R. 16 E.

Ap—0 to 10 inches; very dark gray (10YR 3/1) silt loam, dark gray (10YR 4/1) dry; weak fine subangular blocky structure; very friable; common fine roots; high content of very fine sand; neutral; abrupt smooth boundary.

B21—10 to 16 inches; yellowish brown (10YR 5/4) silt loam; common medium distinct light brownish gray (10YR 6/2) mottles and many fine distinct yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; very friable; few fine roots; high content of very fine sand; neutral; clear wavy boundary.

B22g—16 to 21 inches; light brownish gray (10YR 6/2) silt loam; few fine faint grayish brown (2.5Y 5/2) mottles and common fine prominent yellowish brown (10YR 5/6) mottles; weak medium subangular blocky structure; very friable; few fine roots; neutral; clear wavy boundary.

B23g—21 to 24 inches; grayish brown (2.5Y 5/2) silt loam; common fine faint light brownish gray (10YR 6/2) mottles and few fine prominent yellowish brown (10YR 5/6) mottles; weak fine subangular blocky structure; friable; few fine roots; slight effervescence; mildly alkaline; abrupt wavy boundary.

C—24 to 60 inches; strong brown (7.5YR 5/6) very fine sand and very fine sandy loam, stratified; common fine distinct strong brown (7.5YR 5/8) mottles, common medium distinct yellowish red (5YR 5/8) mottles, and common fine prominent light brownish gray (10YR 6/2) mottles; weak medium platy structure; very friable; few very thin strata of silt loam; slight effervescence; moderately alkaline.

Thickness of the solum ranges from 20 to 36 inches. The solum is neutral or mildly alkaline. Free carbonates are at depths of 18 to 24 inches. The mollic epipedon is 8 to 10 inches thick.

The Ap horizon has value of 2 or 3 and chroma of 1 or 2. The B horizon has 7.5YR, 10YR, or 2.5Y hue, value of 4 through 6, and chroma of 2 through 4. Chroma of 2 occurs in the lower part of the B horizon. This horizon is silt loam, loam, very fine sandy loam, loamy very fine sand, or very fine sand. The C horizon is mildly or moderately alkaline. It has strata of silt, very fine sand, or fine sand.

Zittau series

The Zittau series consists of somewhat poorly drained soils that are slowly permeable in the upper part and rapidly permeable in the lower part. These soils formed in clayey water-laid sediment over sandy material. They are in lake basins and on stream terraces. Slopes are 0 to 3 percent.

Zittau soils formed in the same kind of material as the nearby Borth and Poy soils. The moderately well drained Borth soils, in higher landscape positions, do not have mottles with chroma of 2 or less in the upper 10 inches of the argillic horizon. The poorly drained Poy soils are in depressional areas.

Typical pedon in an area of Zittau silty clay loam, 0 to 3 percent slopes, 440 feet east and 100 feet north of southwest corner NE1/4 sec. 3, T. 18 N., R. 15 E.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silty clay loam; dark gray (10YR 4/1) dry; weak medium subangular blocky structure; firm; common fine roots; neutral; abrupt smooth boundary.

A2—7 to 9 inches; brown (7.5YR 4/2) clay; many fine prominent yellowish red (5YR 4/8) mottles; weak thin platy structure; firm; common fine roots; neutral; abrupt broken boundary.

B21t—9 to 14 inches; reddish brown (5YR 4/3) clay; many fine prominent yellowish red (5YR 4/6), common fine distinct brown (7.5YR 5/2), and many coarse faint brown (7.5YR 4/2) mottles; moderate fine angular and subangular blocky structure; firm; common fine roots; common thin clay films on faces of peds; mildly alkaline; clear wavy boundary.

B22t—14 to 20 inches; reddish brown (5YR 4/3) clay; common fine prominent yellowish red (5YR 4/6), common medium distinct brown (7.5YR 5/2), and many coarse faint brown (7.5YR 4/2) mottles; moderate medium angular and subangular blocky structure; firm; common fine roots; common thin clay films on faces of peds; mildly alkaline; clear wavy boundary.

B31t—20 to 26 inches; reddish brown (5YR 5/3) clay; many medium prominent olive gray (5Y 5/2) mottles; moderate fine prismatic structure; firm; few fine roots; few thin clay films on faces of peds; common

dark gray (10YR 4/1) stains on faces of prisms; strong effervescence with pink (5YR 7/3) lime concentrated in areas of the mass; mildly alkaline; clear wavy boundary.

B32t—26 to 33 inches; reddish brown (5YR 5/3) clay; many coarse prominent greenish gray (5GY 6/1) mottles; moderate medium prismatic structure; firm; few fine roots; few thin clay films on faces of peds; common dark brown (7.5YR 4/2) stains on faces of peds; violent effervescence with many pink (5YR 7/3) lime segregations; moderately akaline; abrupt smooth boundary.

IIC—33 to 60 inches; brown (7.5YR 5/4) fine and medium sand; common medium prominent strong brown (7.5YR 5/8) and many coarse distinct brown (7.5YR 5/2) mottles; single grained; loose; mildly alkaline.

Thickness of the solum and depth to the underlying sand range from 20 to 40 inches. The solum ranges from slightly acid to moderately alkaline.

The Ap horizon has 10YR or 7.5YR hue, value of 2 or 3, and chroma of 1 or 2. It is 6 to 9 inches thick. Some pedons have an A1 horizon that is 3 or 4 inches thick. Some pedons have no A2 horizon. The B horizon commonly is clay, but some pedons have subhorizons of silty clay. In some pedons as much as 9 inches in the lower part of the B horizon has chroma of 1 or 2. The IIC horizon is neutral or mildly alkaline.

Formation of the soils

The following paragraphs describe the factors of soil formation, relate these factors to the formation of soils in the survey area, and explain the processes of soil formation (*3*).

The soils of Winnebago County formed through the action of climate and living organisms upon parent material, as conditioned by local factors of relief. The total effect of these four factors depends on the length of time the soil material has been in place. Each of these factors affects the formation of every soil, but the relative importance of each differs from place to place. One factor, for example, may dominate the formation of a soil and determine most of its properties. In general, however, the effect of each of these factors—parent material, climate, living organisms, relief, and time—is modified by the effect of the others.

Physical, chemical, and biological reactions result from the interaction of the factors of soil formation. These reactions occur in such soil-forming processes as accumulation of organic matter in the surface layer, transformation of soil material, and the removal, transfer, and deposition of soil components from one part of the soil profile to another.

The results of the soil-forming processes can readily be seen in the McHenry soils. The parent material was windblown silt and the underlying calcareous fine sandy loam glacial till. The gently sloping and sloping relief influenced the other factors of soil formation by affecting water movement. It affected the amount of water available for percolation and contributed to the characteristics that made these soils well drained. The temperate climate and rainfall affected organic matter formation and decomposition and were conducive to dissolving minerals and moving them in solution downward in the soil profile. Living organisms contributed to the accumulation of organic matter and organic acids and mixed the soil to some extent. They were also conducive to the downward movement of water in the soil profile. In time, these processes were accelerated.

Free lime in the soil material was gradually dissolved and moved downward by percolating water. As a result of this leaching, McHenry soils have an acid subsoil. The substratum remains calcareous. Organic acids formed in the upper part of the soil profile and acted upon the parent material to form secondary clay minerals. These suspended clay particles were moved downward and deposited on the faces of peds and in cracks and pores. As a result, the lower part of the silty layer and the upper part of the glacial till in the McHenry subsoil contain more clay than other parts of the soil. While clay and dissolved lime were being moved downward, organic matter in various stages of decomposition was accumulating in the surface layer. As a result of this decomposed organic matter, the surface layer is darker than it was originally.

As a result of these soil-forming processes, McHenry soils now have a dark grayish brown silt loam surface layer, a medium acid heavy silt loam upper subsoil that contains more clay than the surface layer, and a slightly acid clay loam lower subsoil. They are underlain at a depth of about 32 inches by unweathered calcareous fine sandy loam glacial till that has changed little since it was deposited by a glacier.

The soil-forming processes are occurring in all the soils of the survey area in varying degrees. In Winnebago County, the kinds of parent material and the relief have determined to a large extent the kinds of processes that have been dominant in the formation of the soils.

Parent material

About 85 percent of the soils in Winnebago County formed wholly or partly in material deposited by glaciers. Much of this material was later covered by windblown deposits of silty or sandy material. Some soils formed in more recent deposits of organic material, alluvium, or deep windblown material.

Winnebago County was covered by several glaciers. The ice sheets came from the northeast and moved slowly across the county in a general southwesterly direction. The glacial drift they deposited was derived from local bedrock formations, from material deposited by previous glaciers, and from material transported into the

county, such as granite rock and reddish clayey material (fig. 10). The glacial drift is several hundred feet thick in places. The soils of the survey area have derived many of their characteristics from glacial material, for example, color, carbonate content, texture, and content and type of gravel.

The most recent glacier, the Valders ice sheet, which covered all but the southwestern part of the county,

Figure 10.—Thin layer of glacial material over bedded limestone. This material was derived mostly from local glaciated limestone formations.

melted about 11,500 years ago. Its furthest advance in the county, called the terminal moraine, corresponds to the southwestern boundary of the Kewaunee-Manawa-Hortonville map unit on the general soil map. One small lobe of this ice sheet advanced as far south as Rush Lake and created a horseshoe-shaped ridge along the southwestern edge of Waukau Marsh. The Valders ice sheet deposited a characteristic reddish, clayey drift. As this ice sheet advanced, it reworked some of the red clay from the bed of Lake Michigan, mixed it with limestone rock, and deposited it as ground moraines and glaciolacustrine sediment.

The Cary ice sheet covered all of the county many years before the advance of the Valders ice sheet. The drift it deposited is generally much thicker than the Valders drift. This older drift fills the buried valleys in the bedrock surface. It generally underlies the Valders drift, but in the southwestern part of the county it is a silt-covered surface deposit. It is characterized by yellowish brown, loamy till that is high in content of limestone fragments.

Deposits of till, outwash, and lacustrine material remained after the glacial ice melted. Glacial till consisting of poorly sorted, crushed, and mixed clay, silt, sand, and boulders is most common in the survey area. About 171,000 acres of soil formed wholly or partly in this parent material. About 85 percent of these till soils, for example, the Hortonville, Kewaunee, Manawa, and Poygan soils, formed in the Valders till, a reddish till containing more clay and less sand and coarse fragments than the Cary till. Omro soils formed in areas that have a thin deposit of Valders till over Cary soils. Hochheim and Nenno soils formed in Cary till within areas of Valders till. In these small areas, the underlying Cary till was not covered by Valders till and is exposed at the surface.

The Cary till in the southwestern part of the county has more hills and ridges than the Valders till. It was derived mostly from local limestone and sandstone formations that were ground up by the Cary ice sheet. The Cary till east of Rush Lake, mostly fine sandy loam, has a higher calcium carbonate content and contains more limestone fragments than the Cary till west of Rush Lake. Lamartine, LeRoy, and Lomira soils formed in the area east of Rush Lake. Kidder, McHenry, Plano, and St. Charles soils formed in the sandy loam and fine sandy loam Cary till west of Rush Lake.

Knowles, Ritchey, and Whalan soils formed in till deposits that are underlain by limestone bedrock within a depth of 40 inches. All of the Knowles soils formed in the Cary till near Rush Lake. Eleva soils formed west of Rush Lake in a mixture of Cary till and sandstone residuum.

About 92,000 acres of soil in the survey area formed wholly or partly in material deposited by flowing meltwater from the glaciers. These outwash and lacustrine deposits are often interbedded or laminated. The coarser textured outwash deposits, about 15,000 acres, are mostly gravel, sand, and silt and are commonly stratified. Casco and Fox soils formed in deep deposits of this outwash. The Lorenzo Variant, Mosel, and Navan soils formed in thin deposits of outwash over glacial till.

The finer textured lacustrine material, ranging from clay to sand, was deposited in glacial lakes and valleys and in swales in the uplands by slowly moving or ponded water from melting ice. About 62,000 acres of soil in the survey area—Borth, Kaukauna, Menasha, Nebago, Nebago Variant, Neenah, Poy, Winneconne, and Zittau soils—formed wholly or partly in clayey lacustrine material deposited in glacial lake basins. Fisk, Keowns, Korobago, Wauseon, and Yahara soils formed wholly or partly in lacustrine deposits of silt, fine sand, and very fine sand that are commonly stratified. Korobago and Wauseon soils are mostly in swale areas of moraines that have a thin deposit of lacustrine material over glacial till.

Windblown deposits of silty or sandy material cover much of the glacial drift in the county. The thickest silty deposits, 1 foot to more than 5 feet thick, cover the Cary drift in the southwestern part of the county. The thicker deposits are in the valleys within this area. Atterberry and Ossian soils are in these valleys. They formed in windblown silt deposits more than 5 feet thick. The silty windblown deposits covering the Valders drift are commonly less than 15 inches thick.

Thick deposits of windblown sand are in the northwest corner of the county. These deposits were the parent material of Brems, Kingsville, Morocco, and Oakville soils. About 12,000 acres of soil—Fisk, Nebago, Nebago Variant, Puchyan, and Tustin soils—formed in areas where 20 to 40 inches of sand was deposited over finer textured material. Some areas of the Hortonville, Kewaunee, Kidder, and Whalan soils have a surface layer that formed in less than 20 inches of windblown sand.

About 2,000 acres of soil formed in alluvial deposits along the major drainageways. Fluvaquents is an example of this type of deposit. Generally, this material has been deposited too recently for distinct soil horizons to have developed.

During the postglacial period, many shallow lakes and waterways were favorable places for the growth of aquatic plants. About 28,600 acres of organic soils—Adrian, Edwards, Houghton, Palms and Willette soils—formed mostly in the decomposed residue of these aquatic plants.

Climate

Winnebago County has a continental climate that is characteristic of the north central states. This climate has a direct effect on soil formation through the weathering of rocks and alteration of parent material. By supplying energy and a suitable environment for growth of organisms, climate also indirectly affects the accumulations of organic matter and increases soil fertility.

Precipitation and temperature are the chief elements of climate responsible for soil features. These elements

determine the amount of water available for percolation and the formation and decomposition of organic matter, the major processes in the formation of soils.

Percolating water from rainfall and snowmelt affects both the solution and hydration of mineral matter and the organic substances. In addition, the movement of this water also controls the distribution of substances throughout the soil.

Under the same amount of moisture, different soil profiles will develop as a result of differences in temperature. A frozen soil layer, for example, slows down soil-forming processes by restricting the percolation of water. All the soils in Winnebago County have a seasonal frozen layer. The processes of soil formation, therefore, are very slow or absent in winter. The physical action of frost heave also affects profile development. The high temperature in summer increases the evaporation and transpiration of moisture, thus limiting the amount of percolating water available for soil development. Temperature also affects the growth and decomposition of organic matter. Decomposition is much slower in cooler climates.

Wind, another element of climate that affects soil formation, indirectly affects the moisture content of soils by influencing the evaporation rate. In addition, fine particles of soil and organic material are often blown away by winds, thereby eroding the surface layer. These particles are deposited elsewhere as new parent material.

Climate is modified by variations in relief and slope aspect. On the steeper slopes, more precipitation is lost through runoff than in areas where slopes are more gentle. In these places, less water penetrates the surface to furnish moisture for plant growth, microbiological activity, and rock disintegration. As a result, soil formation is generally slower in the steeper areas.

The soils on south- or west-facing slopes are warmed and dried by the sun and wind more than those on north- or east-facing slopes. The cooler, more humid, north- and east-facing slopes generally contain more moisture and are more favorable for the growth of trees than of grasses.

Living organisms

Plants are the principal living organisms that influence the formation of the soils in the county, but bacteria, fungi, insects, earthworms, and rodents are also important. Two of the chief functions of plant and animal life are supplying organic matter to the soil and bringing nutrients from the lower part of the soil profile to the upper layers.

Plant roots penetrate the soil body, thereby creating channels for percolating water. The roots excrete a number of acid substances that act on rocks and minerals and bring nutrients or mineral substances into solution. These nutrients are absorbed and translocated upward to stems and leaves. When the plants die, the translocated minerals are released to upper soil layers. The organic acids formed from the decaying plant residue accelerate soil formation by reacting with rock and mineral constituents.

Plants indirectly affect soil formation by modifying the elements of climate. For example, they reduce the force of winds, thereby influencing the evaporation rate of percolating water and the deposition of windblown parent material.

The influence of vegetation on soil characteristics can be seen in the contrast between the dark colored soils, such as Plano soils, which formed under grass, and the lighter colored soils, such as St. Charles soils, which formed under trees. More organic matter accumulates under grass than under trees.

Animals influence soil formation. They dig into the soil and mix the material of the different layers. Roots and percolating water follow the channels they create. Animal life affects soil structure, helps to decompose organic matter, and carries nutrients upward in the soil profile. When these animals die, they contribute to the supply of organic matter in the soil.

Man has been responsible for extensive changes in the soil. He has altered the pH value and fertility of soils by liming and fertilizing, perpetuated grass by burning over areas that are normally wooded, used cropping practices that cause organic matter to be lost, altered soil moisture content by irrigation and artificial drainage, and accelerated erosion by removing the natural plant cover on sloping soils. Man's activities have had a definite effect on soil profiles.

Relief

Relief influences the formation of soils in its control of drainage, runoff, and erosion. Differences in elevation and slope are closely related to differences in the drainage, the thickness and organic matter content of the topsoil, the thickness of the soil profile, and the degree of erosion.

Sloping soils, such as Kidder and LeRoy soils, that have convex slopes commonly are well drained; they show no evidence of mottling. Because of a higher rate of runoff, they absorb less water than soils that have gentler slopes. Consequently, they tend to have a thinner profile, less horizon development, and more erosion. Erosion removes products of weathering that would contribute to the development of the soil profile.

Moderately well drained soils, such as Borth and Winneconne soils, are mottled in the substratum and in the lower part of the subsoil. They commonly have gentler slopes and are lower on the landscape than the well drained soils.

Runoff is slow on somewhat poorly drained soils, such as Atterberry and Manawa soils. These soils are mottled in the subsoil and substratum. These nearly level and gently sloping soils are on foot slopes adjacent to depressional areas. They commonly receive runoff from adjacent uplands.

Poorly drained soils, such as Ossian and Poygan soils, are in low concave areas. They have a grayish subsoil as a result of excessive moisture and poor aeration. Runoff is very slow or ponded, and the soils are saturated at or near the surface for long periods.

The thickness and organic matter content of the surface layer are commonly related to relief. The nearly level and gently sloping soils generally have a darker and thicker surface layer than the steeper soils. Runoff is slower or ponded on the less sloping soils and these soils absorb more moisture. As a result, the moisture content is more favorable for plant growth and for the accumulation of organic matter. In some wet depressions, decomposing plant residue accumulates to a depth of several feet, forming organic soil.

Time

The degree of horizon development depends on the length of time the soil-forming processes have been active. Some soils, however, form more rapidly than others. The length of time needed for the formation of a particular kind of soil depends on the other factors involved.

When soil begins to form, the characteristics of the soil material and parent material are almost identical; the soils are said to be immature. Fluvaquents, for example, are immature soils in Winnebago County. These soils have few or no genetic differences between horizons. Generally, a soil is considered mature if it has well defined horizons as the result of soil-forming processes that have been active for thousands of years. Such well developed soils as Kewaunee soils are about 11,500 years old.

References

(1) American Association of State Highway [and Transportation] Officials. 1970. Standard specifications for highway materials and methods of sampling and testing. Ed. 10, 2 vol., illus.

(2) American Society for Testing and Materials. 1974. Method for classification of soils for engineering purposes. ASTM Stand. D 2487-69. *In* 1974 Annual Book of ASTM Standards, Part 19, 464 pp., illus.

(3) Jenny, Hans. 1941. Factors of soil formation. McGraw-Hill Book Company, Inc., 281 pp., illus.

(4) Olcott, Perry G. 1966. Geology and water resources of Winnebago County, Wisconsin. Geol. Surv. Water Supply Paper 1814. Univ. Wis. Geol. and Nat. Hist. Surv., 61 pp., illus.

(5) Shaw, Samuel P. and C. Gorden Fredine. 1956. Wetlands of the United States. U.S. Dep. Int. Fish and Wildl. Circ. 39, 67 pp., illus.

(6) United States Department of Agriculture. 1951. Soil survey manual. U.S. Dep. Agric. Handb. 18, 503 pp., illus. [Supplements replacing pp. 173-188 issued May 1962]

(7) United States Department of Agriculture. 1961. Land capability classification. U.S. Dep. Agric. Handb. 210, 21 pp.

(8) United States Department of Agriculture. 1975. Soil taxonomy. A basic system of soil classification for making and interpreting soil surveys. Soil Conserv. Serv., U.S. Dep. Agric. Handb. 436, 754 pp., illus.

(9) University of Wisconsin Geological and Natural History Survey. 1965. Early vegetation of Wisconsin. Univ. Wis., Madison, Wis, 1 p.

(10) Wisconsin Conservation Needs Committee. 1970. Wisconsin soil and water conservation needs inventory. Soil Conserv. Serv., pp. 32-33, illus.

(11) Wisconsin Department of Natural Resources. 1968. Wisconsin forest resource statistics, Lake Winnebago survey report. Wis. Dep. Nat. Resour., 25 pp.

(12) Wisconsin Statistical Reporting Service. 1975. 1975 Wisconsin agricultural statistics. Wis. Rep. Serv., Madison, Wis., 83 pp., illus.

Glossary

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim (in tables). An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	9 to 12
Very high	More than 12

Bedrock. The solid rock that underlies the soil and other unconsolidated material or that is exposed at the surface.

Blowout. A shallow depression from which all or most of the soil material has been removed by wind. A blowout has a flat or irregular floor formed by a resistant layer or by an accumulation of pebbles or cobbles. In some blowouts the water table is exposed.

Boulders. Rock fragments larger than 2 feet (60 centimeters) in diameter.

Calcareous soil. A soil containing enough calcium carbonate (commonly combined with magnesium carbonate) to effervesce visibly when treated with cold, dilute hydrochloric acid.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coating, clay skin.

Coarse fragments. Mineral or rock particles 2 millimeters to 25 centimeters (10 inches) in diameter.

Coarse textured soil. Sand or loamy sand.

Cobblestone (or cobble). A rounded or partly rounded fragment of rock 3 to 10 inches (7.5 to 25 centimeters) in diameter.

Complex slope. Irregular or variable slope. Planning or constructing terraces, diversions, and other water-control measures on a complex slope is difficult.

Compressible (in tables). Excessive decrease in volume of soft soil under load.

Concretions. Grains, pellets, or nodules of various sizes, shapes, and colors consisting of concentrated compounds or cemented soil grains. The composition of most concretions is unlike that of the surrounding soil. Calcium carbonate and iron oxide are common compounds in concretions.

Conservation tillage. A tillage system that does not invert the soil and that leaves all or part of the crop residue on the surface throughout the year.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Contour stripcropping (or contour farming). Growing crops in strips that follow the contour. Strips of grass or close-growing crops are alternated with strips of clean-tilled crops or summer fallow.

Control section. The part of the soil on which classification is based. The thickness varies among different kinds of soil, but for many it is that part of the soil profile between depths of 10 inches and 40 or 80 inches.

Corrosive. High risk of corrosion to uncoated steel or deterioration of concrete.

Cover crop. A close-growing crop grown primarily to improve and protect the soil between periods of regular crop production, or a crop grown between trees and vines in orchards and vineyards.

Cutbanks cave (in tables). The walls of excavations tend to cave in or slough.

Deferred grazing. Postponing grazing or arresting grazing for a prescribed period.

Depth to rock. Bedrock is too near the surface for the specified use.

Diversion (or diversion terrace). A ridge of earth, generally a terrace, built to protect downslope areas by diverting runoff from its natural course.

Drainage class (natural). Refers to the frequency and duration of periods of saturation or partial saturation during soil formation, as opposed to altered drainage, which is commonly the result of artificial drainage or irrigation but may be caused by the sudden deepening of channels or the blocking of drainage outlets. Seven classes of natural soil drainage are recognized:

Well drained.—Water is removed from the soil readily, but not rapidly. It is available to plants throughout most of the growing season, and wetness does not inhibit growth of roots for significant periods during most growing seasons. Well drained soils are commonly medium textured. They are mainly free of mottling.

Moderately well drained.—Water is removed from the soil somewhat slowly during some periods. Moderately well drained soils are wet for only a short time during the growing season, but periodically for long enough that most mesophytic crops are affected. They commonly have a slowly pervious layer within or directly below the solum, or periodically receive high rainfall, or both.

Somewhat poorly drained.—Water is removed slowly enough that the soil is wet for significant periods during the growing season. Wetness markedly restricts the growth of mesophytic crops unless artificial drainage is provided. Somewhat poorly drained soils commonly have a slowly pervious layer, a high water table, additional water from seepage, nearly continuous rainfall, or a combination of these.

Poorly drained.—Water is removed so slowly that the soil is saturated periodically during the growing season or remains wet for long periods. Free water is commonly at or near the surface for long enough during the growing season that most mesophytic crops cannot be grown unless the soil is artificially drained. The soil is not continuously saturated in layers directly below plow depth. Poor drainage results from a high water table, a slowly pervious layer within the profile, seepage, nearly continuous rainfall, or a combination of these.

Very poorly drained.—Water is removed from the soil so slowly that free water remains at or on the surface during most of the growing season. Unless the soil is artificially drained, most mesophytic crops cannot be grown. Very poorly drained soils are commonly level or depressed and are frequently ponded. Yet, where rainfall is high and nearly con-

tinuous, they can have moderate or high slope gradients.

Drainage, surface. Runoff, or surface flow of water, from an area.

Drumlin. A low, smooth, elongated oval hill, mound, or ridge of compact glacial till. The longer axis is parallel to the path of the glacier and commonly has a blunt nose pointing in the direction from which the ice approached.

Erosion. The wearing away of the land surface by water, wind, ice, or other geologic agents and by such processes as gravitational creep.
Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes the surface.

Esker (geology). A narrow, winding ridge of stratified gravelly and sandy drift deposited by a stream flowing in a tunnel beneath a glacier.

Excess fines (in tables). Excess silt and clay in the soil. The soil does not provide a source of gravel or sand for construction purposes.

Fast intake (in tables). The rapid movement of water into the soil.

Fertility, soil. The quality that enables a soil to provide plant nutrients, in adequate amounts and in proper balance, for the growth of specified plants when light, moisture, temperature, tilth, and other growth factors are favorable.

Fine textured soil. Sandy clay, silty clay, and clay.

Flood plain. A nearly level alluvial plain that borders a stream and is subject to flooding unless protected artificially.

Foot slope. The inclined surface at the base of a hill.

Frost action (in tables). Freezing and thawing of soil moisture. Frost action can damage roads, buildings and other structures, and plant roots.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the sorted and unsorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by glacial melt water.

Glacial till (geology). Unsorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Glaciofluvial deposits (geology). Material moved by glaciers and subsequently sorted and deposited by streams flowing from the melting ice. The deposits are stratified and occur as kames, eskers, deltas, and outwash plains.

Glaciolacustrine deposits. Material ranging from fine clay to sand derived from glaciers and deposited in glacial lakes mainly by glacial melt water. Many deposits are interbedded or laminated.

Gleyed soil. Soil that formed under poor drainage, resulting in the reduction of iron and other elements in the profile and in gray colors and mottles.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Gravel. Rounded or angular fragments of rock up to 3 inches (2 millimeters to 7.5 centimeters) in diameter. An individual piece is a pebble.

Gravelly soil material. Material that is 15 to 50 percent, by volume, rounded or angular rock fragments, not prominently flattened, up to 3 inches (7.5 centimeters) in diameter.

Ground water (geology). Water filling all the unblocked pores of underlying material below the water table.

Gully. A miniature valley with steep sides cut by running water and through which water ordinarily runs only after rainfall. The distinction between a gully and a rill is one of depth. A gully generally is an obstacle to farm machinery and is too deep to be obliterated by ordinary tillage; a rill is of lesser depth and can be smoothed over by ordinary tillage.

Hemic soil material (mucky peat). Organic soil material intermediate in degree of decomposition between the less decomposed fibric and the more decomposed sapric material.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. In the identification of soil horizons, an upper case letter represents the major horizons. Numbers or lower case letters that follow represent subdivisions of the major horizons. An explanation of the subdivisions is given in the *Soil Survey Manual*. The major horizons of mineral soil are as follows:
O horizon.—An organic layer of fresh and decaying plant residue at the surface of a mineral soil.
A horizon.—The mineral horizon at or near the surface in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon, most of which was originally part of a B horizon.
B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of transition from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics such as (1) accumulation of clay, sesquioxides, humus, or a combination of these; (2) prismatic or blocky structure; (3) redder or browner colors than those in the A horizon; or (4) a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil does not have a B horizon, the A horizon alone is the solum.
C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that in which the solum formed. If the material is known to differ from that in the solum, the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Hydrologic soil groups. Refers to soils grouped according to their runoff-producing characteristics. The chief consideration is the inherent capacity of soil bare of vegetation to permit infiltration. The slope and the kind of plant cover are not considered but are separate factors in predicting runoff. Soils are assigned to four groups. In group A are soils having a high infiltration rate when thoroughly wet and having a low runoff potential. They are mainly deep, well drained, and sandy or gravelly. In group D, at the other extreme, are soils having a very slow infiltration rate and thus a high runoff potential. They have a claypan or clay layer at or near the surface, have a permanent high water table, or are shallow over nearly impervious bedrock or other material. A soil is assigned to two hydrologic groups if part of the acreage is artificially drained and part is undrained.

Impervious soil. A soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.

Infiltration. The downward entry of water into the immediate surface of soil or other material, as contrasted with percolation, which is movement of water through soil layers or material.

Infiltration rate. The rate at which water penetrates the surface of the soil at any given instant, usually expressed in inches per hour. The rate can be limited by the infiltration capacity of the soil or the rate at which water is applied at the surface.

Kame (geology). An irregular, short ridge or hill of stratified glacial drift.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Leaching. The removal of soluble material from soil or other material by percolating water.

Liquid limit. The moisture content at which the soil passes from a plastic to a liquid state.

Loam. Soil material that is 7 to 27 percent clay particles, 28 to 50 percent silt particles, and less than 52 percent sand particles.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. The soil is not strong enough to support loads.

Medium textured soil. Very fine sandy loam, loam, silt loam, or silt.

Mineral soil. Soil that is mainly mineral material and low in organic material. Its bulk density is more than that of organic soil.

Minimum tillage. Only the tillage essential to crop production and prevention of soil damage.

Miscellaneous areas. Areas that have little or no natural soil and support little or no vegetation.

Moraine (geology). An accumulation of earth, stones, and other debris deposited by a glacier. Some types are terminal, lateral, medial, and ground.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—*few, common,* and *many*; size—*fine, medium,* and *coarse*; and contrast—*faint, distinct,* and *prominent*. The size measurements are of the diameter along the greatest dimension. *Fine* indicates less than 5 millimeters (about 0.2 inch); *medium*, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and *coarse*, more than 15 millimeters (about 0.6 inch).

Muck. Dark colored, finely divided, well decomposed organic soil material. (See Sapric soil material.)

Neutral soil. A soil having a pH value between 6.6 and 7.3. (See Reaction, soil.)

Nutrient, plant. Any element taken in by a plant essential to its growth. Plant nutrients are mainly nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, and zinc obtained from the soil and carbon, hydrogen, and oxygen obtained from the air and water.

Outwash, glacial. Stratified sand and gravel produced by glaciers and carried, sorted, and deposited by glacial melt water.

Outwash plain. A landform of mainly sandy or coarse textured material of glaciofluvial origin. An outwash plain is commonly smooth; where pitted, it is generally low in relief.

Parent material. The unconsolidated organic and mineral material in which soil forms.

Peat. Unconsolidated material, largely undecomposed organic matter, that has accumulated under excess moisture.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Pedon. The smallest volume that can be called "a soil." A pedon is three dimensional and large enough to permit study of all horizons. Its area ranges from about 10 to 100 square feet (1 square meter to 10 square meters), depending on the variability of the soil.

Percolation. The downward movement of water through the soil.

Percs slowly (in tables). The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality of the soil that enables water to move downward through the profile. Permeability is measured as the number of inches per hour that water moves downward through the saturated soil.

Terms describing permeability are:

Very slow	less than 0.06 inch
Slow	0.06 to 0.20 inch
Moderately slow	0.2 to 0.6 inch
Moderate	0.6 inch to 2.0 inches
Moderately rapid	2.0 to 6.0 inches
Rapid	6.0 to 20 inches
Very rapid	more than 20 inches

Phase, soil. A subdivision of a soil series based on features that affect its use and management. For example, slope, differences in slope, stoniness, and thickness.

pH value. A numerical designation of acidity and alkalinity in soil. (See Reaction, soil.)

Piping (in tables). Formation of subsurface tunnels or pipelike cavities by water moving through the soil.

Plasticity index. The numerical difference between the liquid limit and the plastic limit; the range of moisture content within which the soil remains plastic.

Plastic limit. The moisture content at which a soil changes from semisolid to plastic..

Poorly graded. Refers to a coarse grained soil or soil material consisting mainly of particles of nearly the same size. Because there is little difference in size of the particles, density can be increased only slightly by compaction.

Poor outlets (in tables). Refers to areas where surface or subsurface drainage outlets are difficult or expensive to install.

Productivity (soil). The capability of a soil for producing a specified plant or sequence of plants under specific management.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. A measure of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH
Extremely acid	Below 4.5
Very strongly acid	4.5 to 5.0
Strongly acid	5.1 to 5.5
Medium acid	5.6 to 6.0
Slightly acid	6.1 to 6.5
Neutral	6.6 to 7.3
Mildly alkaline	7.4 to 7.8
Moderately alkaline	7.9 to 8.4
Strongly alkaline	8.5 to 9.0
Very strongly alkaline	9.1 and higher

Regolith. The unconsolidated mantle of weathered rock and soil material on the earth's surface; the loose earth material above the solid rock.

Relief. The elevations or inequalities of a land surface, considered collectively.

Residuum (residual soil material). Unconsolidated, weathered, or partly weathered mineral material that accumulated as consolidated rock disintegrated in place.

Rooting depth (in tables). Shallow root zone. The soil is shallow over a layer that greatly restricts roots.

Root zone. The part of the soil that can be penetrated by plant roots.

Runoff. The precipitation discharged into stream channels from an area. The water that flows off the surface of the land without sinking into the soil is called surface runoff. Water that enters the soil before reaching surface streams is called ground-water runoff or seepage flow from ground water.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Sandstone. Sedimentary rock containing dominantly sand-size particles.

Sapric soil material (muck). The most highly decomposed of all organic soil material. Muck has the least amount of plant fiber, the highest bulk density, and the lowest water content at saturation of all organic soil material.

Sedimentary rock. Rock made up of particles deposited from suspension in water. The chief kinds of sedimentary rock are conglomerate, formed from gravel; sandstone, formed from sand; shale, formed from clay; and limestone, formed from soft masses of calcium carbonate. There are many intermediate types. Some wind-deposited sand is consolidated into sandstone.

Seepage (in tables). The movement of water through the soil. Seepage adversely affects the specified use.

Series, soil. A group of soils that have profiles that are almost alike, except for differences in texture of the surface layer or of the underlying material. All the soils of a series have horizons that are similar in composition, thickness, and arrangement.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Site index. A designation of the quality of a forest site based on the height of the dominant stand at an arbitrarily chosen age. For example, if the average height attained by dominant and codominant trees in a fully stocked stand at the age of 50 years is 75 feet, the site index is 75 feet.

Slope. The inclination of the land surface from the horizontal. Percentage of slope is the vertical distance divided by horizontal distance, then multiplied by 100. Thus, a slope of 20 percent is a drop of 20 feet in 100 feet of horizontal distance.

Slow intake (in tables). The slow movement of water into the soil.

Slow refill (in tables). The slow filling of ponds, resulting from restricted permeability in the soil.

Small stones (in tables). Rock fragments less than 3 inches (7.5 centimeters) in diameter. Small stones adversely affect the specified use of the soil.

Soil. A natural, three-dimensional body at the earth's surface. It is capable of supporting plants and has properties resulting from the integrated effect of climate and living matter acting on earthy parent material, as conditioned by relief over periods of time.

Soil separates. Mineral particles less than 2 mm in equivalent diameter and ranging between specified size limits. The names and sizes of separates recognized in the United States are as follows:

	Millimeters
Very coarse sand	2.0 to 1.0
Coarse sand	1.0 to 0.5
Medium sand	0.5 to 0.25
Fine sand	0.25 to 0.10
Very fine sand	0.10 to 0.05
Silt	0.05 to 0.002
Clay	Less than 0.002

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and plant and animal activities are largely confined to the solum.

Stones. Rock fragments 10 to 24 inches (25 to 60 centimeters) in diameter.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates. The principal forms of soil structure are—*platy* (laminated), *prismatic* (vertical axis of aggregates longer than horizontal), *columnar* (prisms with rounded tops), *blocky* (angular or subangular), and *granular*. *Structureless* soils are either *single grained* (each grain by itself, as in dune sand) or *massive* (the particles adhering without any regular cleavage, as in many hardpans).

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Subsurface layer. Technically, the A2 horizon. Generally refers to a leached horizon lighter in color and lower in content of organic matter than the overlying surface layer.

Surface layer. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Taxadjuncts. Soils that cannot be classified in a series recognized in the classification system. Such soils are named for a series they strongly resemble and are designated as taxadjuncts to that series because they differ in ways too small to be of consequence in interpreting their use and behavior.

Terminal moraine. A belt of thick glacial drift that generally marks the termination of important glacial advances.

Terrace. An embankment, or ridge, constructed across sloping soils on the contour or at a slight angle to the contour. The terrace intercepts surface runoff so that it can soak into the soil or flow slowly to a prepared outlet without harm. A terrace in a field is generally built so that the field can be farmed. A terrace intended mainly for drainage has a deep channel that is maintained in permanent sod.

Terrace (geologic). An old alluvial plain, ordinarily flat or undulating, bordering a river, a lake, or the sea.

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are *sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay,* and *clay*. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or " very fine."

Thin layer (in tables). Otherwise suitable soil material too thin for the specified use.

Till plain. An extensive flat to undulating area underlain by glacial till.

Tilth, soil. The physical condition of the soil as related to tillage, seedbed preparation, seedling emergence, and root penetration.

Topsoil. The upper part of the soil, which is the most favorable material for plant growth. It is ordinarily rich in organic matter and is used to topdress roadbanks, lawns, and land affected by mining.

Trace elements. Chemical elements, for example, zinc, cobalt, manganese, copper, and iron, are in soils in extremely small amounts. They are essential to plant growth.

Upland (geology). Land at a higher elevation, in general, than the alluvial plain or stream terrace; land above the low lands along streams.

Variant, soil. A soil having properties sufficiently different from those of other known soils to justify a new series name, but occurring in such a limited geographic area that creation of a new series is not justified.

Weathering. All physical and chemical changes produced in rocks or other deposits at or near the earth's surface by atmospheric agents. These changes result in disintegration and decomposition of the material.

Well graded. Refers to soil material consisting of coarse grained particles that are well distributed over a wide range in size or diameter. Such soil normally can be easily increased in density and bearing properties by compaction. Contrasts with poorly graded soil.

TABLES

TABLE 1.--TEMPERATURE AND PRECIPITATION

[All data from Oshkosh, Wisconsin, based on records from 1930 to 1959]

Month	Temperature				Precipitation				
	Average daily maximum	Average daily minimum	Two years in 10 will have monthly average of: Maximum temperature equal to or higher than	Two years in 10 will have monthly average of: Minimum temperature equal to or lower than--	Average monthly total	One year in 10 will have--: Less than--	One year in 10 will have--: More than--	Days with 0.1 inch or more precipitation	Average precipitation in the form of snow and sleet
	°F	°F	°F	°F	In	In	In		In
January---	26.8	9.6	24	12	1.29	0.37	2.44	4	10.7
February--	29.2	11.2	24	17	1.19	0.24	2.35	4	8.9
March-----	38.6	21.4	32	27	1.60	0.78	2.51	5	9.4
April-----	54.7	34.4	48	42	2.54	1.04	4.41	6	1.6
May-------	67.8	45.9	60	54	2.83	1.29	4.99	7	0.3
June------	77.9	56.7	70	64	3.91	1.80	7.05	7	.0
July------	83.6	61.2	74	71	2.98	1.05	5.43	5	.0
August----	81.7	59.6	73	68	3.16	1.31	4.99	6	.0
September-	73.0	51.2	65	59	3.08	0.68	6.61	6	*
October---	61.1	40.4	55	48	1.88	0.55	3.93	5	0.2
November--	43.2	27.0	39	31	2.12	0.64	4.58	5	4.0
December--	30.5	15.4	26	18	1.35	0.48	2.15	4	8.7

*Trace.

TABLE 2.--PROBABILITIES OF LAST FREEZING TEMPERATURES IN SPRING AND FIRST IN FALL

[All data are from Oshkosh, Wisconsin, based on records from 1930 to 1959]

Probability	Dates for given probability and temperature				
	16° F or lower	20° F or lower	24° F or lower	28° F or lower	32° F or lower
Spring:					
2 years in 10 later than--	Apr. 2	Apr. 10	Apr. 23	May. 6	May 18
4 years in 10 later than--	Mar. 25	Apr. 3	Apr. 16	Apr. 29	May 12
6 years in 10 later than--	Mar. 19	Mar. 27	Apr. 9	Apr. 23	May. 6
8 years in 10 later than--	Mar. 12	Mar. 19	Apr. 2	Apr. 15	Apr. 29
Fall:					
2 years in 10 earlier than--	Nov. 10	Oct. 28	Oct. 17	Oct. 6	Sept. 24
4 years in 10 earlier than--	Nov. 17	Nov. 4	Oct. 25	Oct. 13	Oct. 1
6 years in 10 earlier than--	Nov. 24	Nov. 10	Oct. 31	Oct. 20	Oct. 7
8 years in 10 earlier than--	Dec. 1	Nov. 18	Nov. 8	Oct. 28	Oct. 14

TABLE 3.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS

Map symbol	Soil name	Acres	Percent
Ak	Adrian muck	1,598	0.4
AtA	Atterberry silt loam, 0 to 3 percent slopes	1,322	0.4
BoB	Borth silty clay loam, 1 to 4 percent slopes	3,646	1.0
BrB	Brems fine sand, 1 to 4 percent slopes	1,980	0.5
CeB	Casco loam, 2 to 6 percent slopes	982	0.3
CeC2	Casco loam, 6 to 15 percent slopes, eroded	795	0.2
Ed	Edwards muck	355	0.1
ElD2	Eleva loam, 8 to 20 percent slopes, eroded	123	*
FkA	Fisk loamy fine sand, 0 to 3 percent slopes	1,280	0.4
Fn	Fluvaquents	1,982	0.5
FsB	Fox silt loam, 2 to 6 percent slopes	1,287	0.4
FsC2	Fox silt loam, 6 to 12 percent slopes, eroded	330	0.1
GnB	Grellton fine sandy loam, 2 to 6 percent slopes	275	0.1
HmB	Hochheim loam, 2 to 6 percent slopes	2,253	0.6
HoB	Hortonville loamy fine sand, 2 to 6 percent slopes	2,176	0.6
HoC2	Hortonville loamy fine sand, 6 to 12 percent slopes, eroded	448	0.1
HrB	Hortonville silt loam, 2 to 6 percent slopes	24,363	6.6
HrC2	Hortonville silt loam, 6 to 12 percent slopes, eroded	1,581	0.4
Hu	Houghton muck	9,477	2.6
Hw	Houghton muck, ponded	4,920	1.3
KaB	Kaukauna silty clay loam, 1 to 4 percent slopes	1,514	0.4
Ke	Keowns silt loam	3,403	0.9
KmB	Kewaunee loamy fine sand, 2 to 6 percent slopes	2,294	0.6
KnB	Kewaunee silt loam, 2 to 6 percent slopes	43,128	11.7
KoC2	Kewaunee silty clay loam, 6 to 12 percent slopes, eroded	2,048	0.6
KpB	Kidder loamy fine sand, 2 to 6 percent slopes	1,011	0.3
KpC2	Kidder loamy fine sand, 6 to 12 percent slopes, eroded	262	0.1
KrB	Kidder silt loam, 2 to 6 percent slopes	542	0.1
KrC2	Kidder silt loam, 6 to 15 percent slopes, eroded	920	0.2
Ks	Kingsville mucky loamy fine sand	859	0.2
KwB	Knowles silt loam, 2 to 6 percent slopes	869	0.2
KwC2	Knowles silt loam, 6 to 12 percent slopes, eroded	287	0.1
KyA	Korobago silt loam, 0 to 3 percent slopes	7,482	2.0
LmA	Lamartine silt loam, 0 to 3 percent slopes	2,684	0.7
LrB	LeRoy silt loam, 2 to 6 percent slopes	3,243	0.9
LrC2	LeRoy silt loam, 6 to 12 percent slopes, eroded	1,971	0.5
LvB	Lomira silt loam, 2 to 6 percent slopes	3,011	0.8
LzB	Lorenzo Variant loam, 2 to 8 percent slopes	2,724	0.7
MaA	Manawa silty clay loam, 0 to 3 percent slopes	30,625	8.3
MhB	McHenry silt loam, 2 to 6 percent slopes	2,242	0.6
MhC2	McHenry silt loam, 6 to 12 percent slopes, eroded	604	0.2
Mn	Menasha clay	9,270	2.5
MoA	Morocco loamy fine sand, 0 to 3 percent slopes	1,397	0.4
MtA	Mosel silt loam, 0 to 3 percent slopes	4,786	1.3
Na	Navan silt loam	2,764	0.8
NeA	Nebago fine sand, 0 to 3 percent slopes	7,069	1.9
Ng	Nebago Variant mucky loamy fine sand	855	0.2
NhA	Neenah silty clay loam, 0 to 3 percent slopes	9,363	2.5
NnA	Nenno loam, 0 to 3 percent slopes	1,038	0.3
OaB	Oakville fine sand, 2 to 6 percent slopes	1,533	0.4
OaC	Oakville fine sand, 6 to 12 percent slopes	364	0.1
OmB	Omro clay loam, 2 to 6 percent slopes	2,283	0.6
Os	Ossian silt loam	4,341	1.2
Pa	Palms muck	2,346	0.6
Pg	Pits, gravel	961	0.3
Ph	Pits, quarries	377	0.1
PsB	Plano silt loam, 2 to 6 percent slopes	1,292	0.4
Pt	Poy silty clay loam	8,887	2.4
Pu	Poygan silty clay loam	6,439	1.7
PzB	Puchyan loamy fine sand, 2 to 6 percent slopes	455	0.1
RhB	Ritchey silt loam, 2 to 6 percent slopes	426	0.1
RhC2	Ritchey silt loam, 6 to 12 percent slopes, eroded	430	0.1
RhD2	Ritchey silt loam, 12 to 30 percent slopes, eroded	373	0.1
ScB	St. Charles silt loam, 2 to 6 percent slopes	1,486	0.4
TuB	Tustin fine sand, 2 to 6 percent slopes	2,353	0.6
UoA	Udorthents, 0 to 3 percent slopes	4,444	1.2
We	Wauseon silt loam	2,666	0.7
WfB	Whalan loamy fine sand, 2 to 8 percent slopes	387	0.1
WhB	Whalan silt loam, 2 to 6 percent slopes	2,117	0.6
WhC2	Whalan silt loam, 6 to 12 percent slopes, eroded	241	0.1

See footnote at end of table.

TABLE 3.--ACREAGE AND PROPORTIONATE EXTENT OF THE SOILS--Continued

Map symbol	Soil name	Acres	Percent
Wm	Willette muck	9,924	2.7
WnB	Winneconne silty clay loam, 1 to 4 percent slopes	7,457	2.0
YaA	Yahara silt loam, 0 to 3 percent slopes	1,398	0.4
ZtA	Zittau silty clay loam, 0 to 3 percent slopes	13,502	3.7
	Water	84,000	22.7
	Total	369,920	100.0

* Less than 0.1 percent.

TABLE 4.--YIELDS PER ACRE OF CROPS AND PASTURE

[All yields were estimated for a high level of management. Absence of a yield figure indicates the crop is seldom grown or is not suited]

Soil name and map symbol	Corn	Corn silage	Oats	Grass-legume hay	Kentucky bluegrass	Soybeans
	Bu	Ton	Bu	Ton	AUM*	Bu
Ak: Adrian	90	15	---	---	---	---
AtA: Atterberry	130	19	80	5.0	4.5	40
BoB: Borth	80	13	60	4.0	3.0	30
BrB: Brems	55	9	45	2.3	1.7	---
CeB: Casco	70	12	55	3.5	3.0	27
CeC2: Casco	60	11	50	3.0	2.5	22
Ed: Edwards	90	15	---	---	---	---
ElD2: Eleva	60	11	50	3.0	2.7	---
FkA: Fisk	85	14	60	3.5	3.5	28
Fn**. Fluvaquents						
FsB: Fox	95	15	70	4.5	4.0	32
FsC2: Fox	85	14	65	4.0	3.5	27
GnB: Grellton	115	18	75	5.0	4.0	35
HmB: Hochheim	95	15	65	4.0	3.5	32
HoB: Hortonville	100	16	80	5.5	4.0	32
HoC2: Hortonville	90	15	75	5.0	4.0	27
HrB: Hortonville	110	17	80	5.5	4.0	32
HrC2: Hortonville	100	16	75	5.0	4.0	27
Hu: Houghton	90	15	---	---	---	---
Hw: Houghton	---	---	---	---	---	---
KaB: Kaukauna	95	16	75	5.0	4.7	35

See footnotes at end of table.

TABLE 4.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Corn silage	Oats	Grass-legume hay	Kentucky bluegrass	Soybeans
	Bu	Ton	Bu	Ton	AUM*	Bu
Ke------------------------ Keowns	120	18	75	5.0	4.5	32
KmB----------------------- Kewaunee	95	16	70	4.5	3.7	32
KnB----------------------- Kewaunee	110	18	80	5.0	4.0	35
KoC2---------------------- Kewaunee	100	17	75	5.0	3.7	30
KpB----------------------- Kidder	100	15	70	4.0	3.5	30
KpC2---------------------- Kidder	90	14	65	3.5	3.0	26
KrB----------------------- Kidder	110	17	80	4.5	4.0	33
KrC2---------------------- Kidder	100	16	75	4.0	3.6	28
Ks------------------------ Kingsville	60	10	50	2.5	2.0	---
KwB----------------------- Knowles	95	15	75	5.0	4.5	32
KwC2---------------------- Knowles	90	14	70	4.5	4.0	27
KyA----------------------- Korobago	120	18	75	5.0	4.5	35
LmA----------------------- Lamartine	125	20	80	5.0	4.3	35
LrB----------------------- LeRoy	95	15	65	4.5	3.5	30
LrC2---------------------- LeRoy	85	14	60	4.0	3.0	26
LvB----------------------- Lomira	120	18	75	5.0	4.0	35
LzB----------------------- Lorenzo Variant	75	13	60	3.0	3.0	26
MaA----------------------- Manawa	110	18	75	5.0	4.5	34
MhB----------------------- McHenry	115	19	80	5.0	4.0	33
MhC2---------------------- McHenry	105	16	75	4.5	3.5	28
Mn------------------------ Menasha	90	15	65	4.0	3.0	28
MoA----------------------- Morocco	55	9	45	2.3	1.7	---
MtA----------------------- Mosel	115	19	75	5.0	4.7	35

See footnotes at end of table.

TABLE 4.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Corn silage	Oats	Grass-legume hay	Kentucky bluegrass	Soybeans
	Bu	Ton	Bu	Ton	AUM*	Bu
Na------------------------ Navan	115	19	75	5.0	4.7	36
NeA----------------------- Nebago	75	12	65	4.0	3.6	26
Ng------------------------ Nebago Variant	75	12	55	3.5	3.0	24
NhA----------------------- Neenah	90	15	65	4.0	3.0	28
NnA----------------------- Nenno	105	17	70	4.5	4.0	34
OaB----------------------- Oakville	50	8	48	2.0	1.7	---
OaC----------------------- Oakville	---	---	---	1.8	1.7	---
OmB----------------------- Omro	100	17	70	5.0	4.3	32
Os------------------------ Ossian	130	19	80	5.0	4.5	42
Pa------------------------ Palms	105	17	---	---	---	---
Pg**, Ph**. Pits						
PsB----------------------- Plano	130	19	80	5.2	4.5	45
Pt------------------------ Poy	95	15	75	4.5	4.0	30
Pu------------------------ Poygan	110	18	75	5.0	4.5	35
PzB----------------------- Puchyan	90	14	65	4.0	3.1	26
RhB----------------------- Ritchey	70	12	55	3.0	3.0	23
RhC2---------------------- Ritchey	60	11	50	2.7	2.5	18
RhD2---------------------- Ritchey	---	---	---	2.3	2.0	---
ScB----------------------- St. Charles	125	19	80	5.0	4.5	36
TuB----------------------- Tustin	80	13	60	3.5	3.0	24
UoA**. Udorthents						
We------------------------ Wauseon	120	18	75	4.5	4.0	28
WfB----------------------- Whalan	80	12	60	4.0	3.0	32

See footnotes at end of table.

TABLE 4.--YIELDS PER ACRE OF CROPS AND PASTURE--Continued

Soil name and map symbol	Corn	Corn silage	Oats	Grass-legume hay	Kentucky bluegrass	Soybeans
	Bu	Ton	Bu	Ton	AUM*	Bu
WhB------------------------ Whalan	85	14	65	4.0	3.0	32
WhC2----------------------- Whalan	70	10	53	3.5	2.7	27
Wm------------------------- Willette	100	16	---	---	---	---
WnB------------------------ Winneconne	95	15	70	5.0	4.3	32
YaA------------------------ Yahara	120	18	75	4.5	4.0	35
ZtA------------------------ Zittau	85	14	65	4.0	3.0	32

* Animal-unit-month: The amount of forage or feed required to feed one animal unit (one cow, one horse, one mule, five sheep, or five goats) for a period of 30 days.

** See map unit description for the composition and behavior of the map unit.

TABLE 5.--CAPABILITY CLASSES AND SUBCLASSES

[All soils are assigned to nonirrigated capability subclasses. Miscellaneous areas and Udorthents are excluded. Dashes mean no acreage]

Class	Total acreage	Major management concerns (Subclass)		
		Erosion (e)	Wetness (w)	Soil problem (s)
		Acres	Acres	Acres
I	---	---	---	---
II	213,123	106,876	106,247	---
III	50,429	15,755	34,674	---
IV	8,947	1,225	4,209	3,513
V	1,982	---	1,982	---
VI	737	373	---	364
VII	---	---	---	---
VIII	4,920	---	4,920	---

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY

[Only the soils suitable for production of commercial trees are listed in this table. Absence of an entry in a column means the information was not available]

Soil name and map symbol	Ordination symbol	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Management concerns: Erosion hazard	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
Ak: Adrian	3w	Severe	Severe	Severe	Slight	Tamarack	45	
						Red maple	---	
						Silver maple	---	
						White ash	---	
						Quaking aspen	---	
						Green ash	---	
AtA: Atterberry	2o	Slight	Slight	Slight	Slight	Northern red oak	65	Eastern white pine, red pine, white spruce.
						White oak	---	
						Silver maple	---	
						White ash	---	
						Green ash	---	
BoB: Borth	3c	Slight	Severe	Slight	Slight	Sugar maple	55	Red pine, eastern white pine, white spruce.
						Red maple	---	
						White ash	---	
						Northern red oak	---	
						American basswood	---	
						Eastern white pine	---	
						Northern pin oak	---	
BrB: Brems	3s	Slight	Moderate	Slight	Slight	Jack pine	58	Eastern white pine, red pine, jack pine.
						Northern pin oak	---	
CeB, CeC2: Casco	3s	Slight	Moderate	Moderate	Slight	Northern red oak	55	Red pine, eastern redcedar, eastern white pine.
						Black oak	---	
						White oak	---	
Ed: Edwards	3w	Severe	Severe	Severe	Slight	Tamarack	45	
						Red maple	---	
						White ash	---	
						Green ash	---	
						Silver maple	---	
						Northern white-cedar	---	
						Black ash	---	
ElD2: Eleva	3r	Moderate	Moderate	Slight	Moderate	Jack pine	60	Jack pine, red pine.
						Black oak	---	
						Northern red oak	---	
FkA: Fisk	3s	Slight	Moderate	Slight	Slight	Eastern white pine	55	Eastern white pine, white spruce, red pine.
						Red maple	---	
						White ash	---	
						American elm	---	
						Silver maple	---	
						Green ash	---	
FsB, FsC2: Fox	2o	Slight	Slight	Slight	Slight	Northern red oak	65	Red pine, eastern white pine, white spruce, Norway spruce.
						White oak	---	
						Sugar maple	---	
GnB: Grellton	1o	Slight	Slight	Slight	Slight	Northern red oak	70	Red pine, eastern white pine, white spruce.
						White oak	---	
						Sugar maple	---	
						White ash	---	
						Green ash	---	

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Equipment limitation	Management concerns: Seedling mortality	Management concerns: Windthrow hazard	Management concerns: Erosion hazard	Potential productivity: Common trees	Potential productivity: Site index	Trees to plant
HmB---------------- Hochheim	2o	Slight	Slight	Slight	Slight	Sugar maple--------- American basswood--- Northern red oak---- White ash-----------	58 --- --- ---	Red pine, eastern white pine.
HoB, HoC2, HrB, HrC2-------------- Hortonville	1o	Slight	Slight	Slight	Slight	Sugar maple--------- Northern red oak---- American basswood---	66 --- ---	Eastern white pine, red pine, white spruce.
Hu----------------- Houghton	3w	Severe	Severe	Severe	Slight	Tamarack------------ Red maple----------- Silver maple-------- White ash----------- Quaking aspen------- Green ash----------- Northern white-cedar	45 --- --- --- --- --- ---	
KaB---------------- Kaukauna	2c	Moderate	Moderate	Slight	Slight	Northern red oak---- Sugar maple--------- White ash----------- Red maple-----------	65 --- --- ---	Eastern white pine, red pine, white spruce.
Ke----------------- Keowns	1w	Severe	Moderate	Moderate	Slight	Silver maple-------- Red maple----------- White ash-----------	--- 90 ---	Silver maple, red maple, white ash.
KmB, KnB, KoC2----- Kewaunee	2c	Slight	Moderate	Slight	Slight	Northern red oak---- American basswood--- Sugar maple--------- White ash-----------	65 --- --- ---	Eastern white pine, red pine, Norway spruce.
KpB, KpC2, KrB, KrC2-------------- Kidder	2o	Slight	Slight	Slight	Slight	Northern red oak---- White ash-----------	65 ---	Eastern white pine, red pine, white spruce.
Ks----------------- Kingsville	4w	Severe	Severe	Severe	Slight	White ash----------- Red maple-----------	50 ---	White ash, red pine.
KwB, KwC2---------- Knowles	2o	Slight	Slight	Slight	Slight	Northern red oak---- White oak----------- Sugar maple---------	65 --- ---	Red pine, eastern white pine.
KyA---------------- Korobago	2o	Slight	Slight	Slight	Slight	Northern red oak---- Red maple----------- White ash----------- American basswood---	66 --- --- ---	Eastern white pine, white spruce.
LmA---------------- Lamartine	2o	Slight	Slight	Slight	Slight	Northern red oak---- American basswood--- Sugar maple---------	65 --- ---	Eastern white pine, red pine, white spruce.
LrB, LrC2---------- LeRoy	2o	Slight	Slight	Slight	Slight	Northern red oak---- Sugar maple--------- American basswood--- White ash-----------	65 --- --- ---	Red pine, eastern white pine, white spruce.

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Equipment limitation	Seedling mortality	Windthrow hazard	Erosion hazard	Potential productivity: Common trees	Site index	Trees to plant
LvB---------------- Lomira	2o	Slight	Slight	Slight	Slight	Northern red oak---- Sugar maple--------- American basswood---	65 --- ---	Red pine, eastern white pine, white spruce.
LzB---------------- Lorenzo Variant	3d	Slight	Moderate	Moderate	Slight	Northern red oak---- Red maple----------- Sugar maple--------- White ash-----------	55 --- --- ---	Eastern white pine, red pine, white spruce.
MaA---------------- Manawa	2c	Slight	Slight	Slight	Slight	Northern red oak---- Sugar maple--------- Green ash----------- Red maple-----------	61 --- --- ---	Red maple, green ash, white ash, white spruce.
MhB, MhC2---------- McHenry	2o	Slight	Slight	Slight	Slight	Northern red oak---- White oak----------- Green ash----------- Bur oak-------------	65 --- --- ---	Eastern white pine, red pine, white spruce.
Mn----------------- Menasha	2w	Moderate	Moderate	Moderate	Slight	White ash----------- Red maple----------- Silver maple-------- Swamp white oak----- Northern red oak---- Green ash----------- American basswood---	65 --- --- --- --- --- ---	Red maple, silver maple, white ash, green ash, white spruce.
MoA---------------- Morocco	3s	Slight	Moderate	Slight	Slight	Red maple----------- Eastern white pine-- Jack pine-----------	60 --- ---	Eastern white pine, European larch, red maple, American sycamore.
MtA---------------- Mosel	2o	Slight	Slight	Slight	Slight	Northern red oak---- American basswood--- Red maple-----------	65 --- ---	Eastern white pine, red pine, white spruce.
Na----------------- Navan	4w	Severe	Moderate	Moderate	Slight	Red maple----------- White ash-----------	45 ---	Red maple, white ash, white spruce.
NeA---------------- Nebago	2s	Slight	Slight	Slight	Slight	Red maple----------- Northern red oak---- White ash----------- Eastern white pine--	73 --- --- ---	White spruce, eastern white pine, white ash, red maple.
Ng----------------- Nebago Variant	4w	Severe	Severe	Severe	Slight	Red maple----------- Northern red oak---- Eastern white pine-- Paper birch--------- American elm--------	45 --- --- --- ---	Eastern white pine, black spruce, white spruce.
NhA---------------- Neenah	2c	Moderate	Moderate	Slight	Slight	Northern red oak---- Sugar maple--------- Green ash----------- Red maple----------- Silver maple-------- White ash----------- Swamp white oak-----	65 --- --- --- --- --- ---	Eastern white pine, green ash, white spruce, white ash, red maple, silver maple.
NnA---------------- Nenno	2o	Slight	Slight	Slight	Slight	Northern red oak---- American basswood--- Red maple-----------	65 --- ---	Eastern white pine, red pine, white spruce.

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns				Potential productivity		Trees to plant
		Equipment limitation	Seedling mortality	Windthrow hazard	Erosion hazard	Common trees	Site index	
OaB, OaC----------- Oakville	4s	Slight	Severe	Slight	Slight	Red pine------------ Black oak----------- Eastern white pine-- Jack pine----------- Northern pin oak----	45 --- --- --- ---	Red pine, eastern white pine, jack pine, Norway spruce.
OmB---------------- Omro	2c	Slight	Severe	Moderate	Slight	Northern red oak---- Sugar maple--------- White ash----------- Red maple-----------	65 --- --- ---	Eastern white pine, red pine, white spruce.
Os----------------- Ossian	3w	Severe	Severe	Severe	Slight	White ash----------- Red maple-----------	55 ---	White ash, red maple, white spruce.
Pa----------------- Palms	3w	Severe	Severe	Severe	Slight	Tamarack------------ Red maple----------- Silver maple-------- White ash----------- Quaking aspen------- Northern white-cedar Black ash-----------	45 --- --- --- --- --- ---	
Pt----------------- Poy	2w	Severe	Moderate	Moderate	Slight	Red maple----------- Swamp white oak----- Northern red oak---- White ash----------- Silver maple-------- Green ash----------- American basswood---	69 --- --- --- --- --- ---	Red maple, silver maple, white ash, green ash, white spruce.
Pu----------------- Poygan	2w	Severe	Moderate	Moderate	Slight	White ash----------- Red maple----------- Silver maple--------	65 --- ---	White spruce, black spruce, red maple, silver maple.
PzB---------------- Puchyan	3o	Slight	Slight	Slight	Slight	Black oak----------- Northern pin oak---- White oak-----------	55 --- ---	Red pine, eastern white pine.
RhB, RhC2, RhD2---- Ritchey	3d	Slight	Moderate	Moderate	Moderate	Northern red oak---- White oak----------- Eastern redcedar---- Bur oak-------------	55 --- --- ---	Red pine, eastern redcedar, jack pine.
ScB---------------- St. Charles	2o	Slight	Slight	Slight	Slight	Northern red oak---- American basswood--- Red maple----------- Sugar maple---------	64 --- --- ---	Red pine, eastern white pine, white spruce.
TuB---------------- Tustin	3o	Slight	Slight	Slight	Slight	Black oak----------- Red pine------------ Eastern white pine-- Northern red oak----	55 --- --- ---	Red pine, eastern white pine.
We----------------- Wauseon	3w	Severe	Severe	Severe	Slight	Silver maple-------- White ash----------- Swamp white oak-----	80 --- ---	Silver maple, white ash, white spruce.
WfB, WhB, WhC2----- Whalan	2o	Slight	Slight	Slight	Slight	Northern red oak---- White oak----------- Shagbark hickory----	65 --- ---	Eastern white pine, red pine.

TABLE 6.--WOODLAND MANAGEMENT AND PRODUCTIVITY--Continued

Soil name and map symbol	Ordination symbol	Management concerns: Equipment limitation	Seedling mortality	Windthrow hazard	Erosion hazard	Potential productivity: Common trees	Site index	Trees to plant
Wm----------------- Willette	3w	Severe	Severe	Severe	Slight	Tamarack------------	45	
						Red maple-----------	---	
						Silver maple--------	---	
						White ash-----------	---	
						Quaking aspen-------	---	
						Northern white-cedar	---	
						Black ash-----------	---	
WnB---------------- Winneconne	2c	Slight	Moderate	Slight	Slight	Northern red oak----	65	Eastern white pine, red pine, white spruce.
						Sugar maple---------	---	
						White ash-----------	---	
						Silver maple--------	---	
						Red maple-----------	---	
YaA---------------- Yahara	2o	Slight	Slight	Slight	Slight	Northern red oak----	70	Eastern white pine, white spruce, silver maple, white ash.
						Sugar maple---------	---	
						Red maple-----------	---	
						American basswood---	---	
						American beech------	---	
ZtA---------------- Zittau	3c	Slight	Moderate	Slight	Slight	Silver maple--------	80	Eastern white pine, white spruce, white ash, red maple.
						Red maple-----------	---	
						White ash-----------	---	
						Eastern white pine--	---	
						Northern red oak----	---	
						American elm--------	---	
						American basswood---	---	

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS

[The symbol < means less than; the symbol > means greater than. Absence of an entry means that trees of the height class do not normally grow on this soil]

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Ak: Adrian	---	Silky dogwood	Japanese tree lilac.	Eastern white pine.	Norway poplar.
AtA: Atterberry	Silky dogwood	Northern white-cedar, American cranberrybush, lilac.	White spruce, black spruce.	Eastern white pine, red pine, green ash, white ash.	Red maple, silver maple.
BoB: Borth	---	Northern white-cedar, common ninebark, silky dogwood, lilac.	White spruce, Norway spruce.	Eastern white pine, red pine.	---
BrB: Brems	Cotoneaster	Lilac, Siberian peashrub.	Eastern redcedar, Norway spruce.	Eastern white pine, jack pine, red pine.	---
CeB, CeC2: Casco	---	Northern white-cedar, lilac, common ninebark, silky dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine.	---
Ed: Edwards	---	Amur privet, silky dogwood, redosier dogwood.	Japanese tree lilac.	Eastern white pine.	Norway poplar.
ElD2: Eleva	Manyflower cotoneaster.	Lilac	Norway spruce, Siberian peashrub.	Eastern white pine, red pine, jack pine.	---
FkA: Fisk	Cotoneaster	Redosier dogwood, nannyberry viburnum.	Green ash, white spruce.	Eastern white pine, jack pine, red pine.	---
Fn*. Fluvaquents					
FsB, FsC2: Fox	---	Northern white-cedar, common ninebark, silky dogwood, lilac.	White spruce, Norway spruce.	Eastern white pine, red pine.	---
GnB: Grellton	---	Northern white-cedar, lilac, common ninebark, silky dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine.	---
HmB: Hochheim	---	Northern white-cedar, lilac, common ninebark, silky dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine.	---
HoB, HoC2, HrB, HrC2: Hortonville	---	Northern white-cedar, common ninebark, silky dogwood, lilac.	White spruce, Norway spruce.	Eastern white pine, red pine.	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
Hu, Hw: Houghton	---	Silky dogwood, Amur privet, redosier dogwood.	Eastern white pine, tamarack.	---	Norway poplar.
KaB: Kaukauna	---	Northern white-cedar, common ninebark, silky dogwood, lilac.	White spruce, Norway spruce.	Eastern white pine, red pine.	---
Ke: Keowns	---	Northern white-cedar, redosier dogwood, nannyberry viburnum.	Green ash, white spruce.	Eastern white pine, jack pine, silver maple.	---
KmB: Kewaunee	---	Northern white-cedar, common ninebark, silky dogwood, lilac.	White spruce, Norway spruce.	Eastern white pine, red pine.	---
KnB, KoC2: Kewaunee	---	Northern white-cedar, lilac, common ninebark, silky dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine.	---
KpB, KpC2, KrB, KrC2: Kidder	---	Northern white-cedar, lilac, common ninebark, silky dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine.	---
Ks: Kingsville	Redosier dogwood, silky dogwood.	---	Northern white-cedar.	White spruce, white ash.	Red maple.
KwB, KwC2: Knowles	---	Northern white-cedar, lilac, common ninebark, silky dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine.	---
KyA: Korobago	---	Northern white-cedar, common ninebark, silky dogwood, lilac.	White spruce, Norway spruce.	Eastern white pine, red pine.	---
LmA: Lamartine	---	Northern white-cedar, lilac, common ninebark, silky dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine.	---
LrB, LrC2: LeRoy	---	Northern white-cedar, lilac, common ninebark, silky dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine.	---
LvB: Lomira	---	Northern white-cedar, lilac, common ninebark, silky dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine.	---
LzB: Lorenzo Variant	Manyflower cotoneaster.	Lilac, Siberian peashrub.	Norway spruce	Eastern white pine, red pine, jack pine.	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of-- <8	8-15	16-25	26-35	>35
MaA: Manawa	---	Northern white-cedar, lilac, common ninebark, silky dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine.	---
MhB, MhC2: McHenry	Gray dogwood, Vanhoutte spirea.	Autumn-olive, Amur honeysuckle, late lilac.	Oriental arborvitae, eastern redcedar.	Norway spruce, eastern white pine, red pine.	---
Mn: Menasha	---	Northern white-cedar, redosier dogwood, nannyberry viburnum.	Green ash, white spruce.	Eastern white pine, jack pine, silver maple.	---
MoA: Morocco	Cotoneaster	Redosier dogwood, nannyberry viburnun.	Green ash, white spruce.	Eastern white pine, jack pine, red pine.	---
MtA: Mosel	---	Northern white-cedar, nannyberry viburnum, redosier dogwood.	White spruce, green ash.	Eastern white pine, jack pine, silver maple.	---
Na: Navan	---	Northern white-cedar, redosier dogwood, nannyberry viburnum.	Green ash, white spruce.	Eastern white pine, jack pine, silver maple.	---
NeA: Nebago	---	Northern white-cedar, redosier dogwood, nannyberry viburnum.	Green ash, white spruce.	Eastern white pine, jack pine, silver maple.	---
Ng: Nebago Variant	---	Northern white-cedar, redosier dogwood, nannyberry viburnum.	Green ash, white spruce.	Eastern white pine, jack pine, silver maple.	---
NhA: Neenah	---	Northern white-cedar, lilac, common ninebark, silky dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine.	---
NnA: Nenno	---	Northern white-cedar, redosier dogwood, nannyberry viburnum.	White spruce, green ash.	Eastern white pine, jack pine, silver maple.	---
OaB, OaC: Oakville	Vanhoutte spirea, Siberian peashrub, cotoneaster.	Lilac, Amur privet.	Red pine, Siberian crabapple.	Eastern white pine.	---
OmB: Omro	---	Northern white-cedar, common ninebark, silky dogwood, lilac.	White spruce, Norway spruce.	Eastern white pine, red pine.	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of-- <8	8-15	16-25	26-35	>35
Os. Ossian	Redosier dogwood, silky dogwood.	Lilac.	Northern white-cedar.	Green ash.	Silver maple, Norway poplar.
Pa. Palms	Vanhoutte spirea, silky dogwood, redosier dogwood.	Lilac.	Tamarack, northern white-cedar.	White spruce.	Green ash, Norway poplar.
Pg*, Ph*. Pits					
PsB. Plano	Gray dogwood, silky dogwood.	Lilac.	Siberian crabapple	Eastern white pine, red pine, Norway spruce.	---
Pt. Poy	---	Northern white-cedar, redosier dogwood, nannyberry viburnum.	Green ash, white spruce.	Eastern white pine, jack pine, silver maple.	---
Pu. Poygan	---	Northern white-cedar, redosier dogwood, nannyberry viburnum.	Green ash, white spruce.	Eastern white pine, silver maple.	---
PzB. Puchyan	Silky dogwood.	Common ninebark, lilac.	White spruce, Norway spruce.	Eastern white pine, red pine.	---
RhB, RhC2, RhD2. Ritchey	Siberian peashrub, gray dogwood.	Lilac.	Norway spruce, eastern redcedar.	Eastern white pine, red pine, jack pine.	---
ScB. St. Charles	Silky dogwood.	Northern white-cedar, American cranberrybush.	White spruce, black spruce, Norway spruce.	Eastern white pine, red pine, green ash, white ash.	Red maple, silver maple.
TuB. Tustin	Manyflower cotoneaster.	Lilac.	Norway spruce, Siberian peashrub.	Eastern white pine, red pine, jack pine.	---
UoA*. Udorthents					
We. Wauseon	---	Northern white-cedar, redosier dogwood, nannyberry viburnum.	Green ash, white spruce.	Eastern white pine, jack pine, silver maple.	---
WfB, WhB, WhC2. Whalan	Silky dogwood, gray dogwood.	Lilac.	Eastern redcedar, white spruce.	Red pine, eastern eastern white pine.	---
Wm. Willette	Vanhoutte spirea, silky dogwood, redosier dogwood.	Lilac.	Tamarack.	---	Norway poplar.
WnB. Winneconne	---	Northern white-cedar, common ninebark, silky dogwood, lilac.	White spruce, Norway spruce.	Eastern white pine, red pine.	---

See footnote at end of table.

TABLE 7.--WINDBREAKS AND ENVIRONMENTAL PLANTINGS--Continued

Soil name and map symbol	Trees having predicted 20-year average heights, in feet, of--				
	<8	8-15	16-25	26-35	>35
YaA---------------- Yahara	---	Northern white-cedar, lilac, common ninebark, silky dogwood.	White spruce, Norway spruce.	Eastern white pine, red pine.	---
ZtA---------------- Zittau	---	Northern white-cedar, common ninebark, silky dogwood, lilac.	White spruce, Norway spruce.	Eastern white pine, red pine.	---

* See map unit description for the composition and behavior of the map unit.

TABLE 8.--BUILDING SITE DEVELOPMENT

[Some of the terms used in this table to describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry means soil was not rated]

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
Ak----------------- Adrian	Severe: wetness, cutbanks cave, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, frost action, low strength.	Severe: excess humus, floods, wetness.
AtA---------------- Atterberry	Severe: wetness.	Severe: low strength, wetness.	Severe: wetness, low strength.	Severe: wetness, low strength.	Severe: frost action, low strength.	Moderate: wetness.
BoB---------------- Borth	Severe: cutbanks cave.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: low strength, shrink-swell.	Moderate: too clayey.
BrB---------------- Brems	Severe: cutbanks cave.	Slight----------	Moderate: wetness.	Slight----------	Slight----------	Severe: too sandy.
CeB---------------- Casco	Severe: cutbanks cave.	Slight----------	Slight----------	Moderate: slope.	Moderate: frost action.	Slight.
CeC2--------------- Casco	Severe: cutbanks cave.	Moderate: slope.	Moderete: slope.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
Ed----------------- Edwards	Severe: floods, wetness.	Severe: floods, wetness, low strength.	Severe: floods, wetness, low strength.	Severe: floods, wetness, low strength.	Severe: frost action, wetness, low strength.	Severe: excess humus, wetness, floods.
ElD2--------------- Eleva	Moderate: slope, depth to rock.	Moderate: slope.	Moderate: slope, depth to rock.	Severe: slope.	Moderate: slope, low strength, frost action.	Moderate: slope, thin layer.
BkA---------------- Fisk	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Severe: frost action.	Moderate: too sandy, wetness.
Fn*. Fluvaquents						
FsB---------------- Fox	Severe: cutbanks cave.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: low strength.	Slight.
FsC2--------------- Fox	Severe: cutbanks cave.	Moderate: slope, shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: slope.	Severe: low strength.	Moderate: slope.
GnB---------------- Grellton	Slight----------	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: low strength.	Slight.
HmB---------------- Hochheim	Slight----------	Slight----------	Slight----------	Moderate: slope.	Moderate: low strength, frost action.	Slight.
HoB---------------- Hortonville	Slight----------	Severe: low strength.	Moderate: low strength, shrink-swell.	Severe: low strength.	Severe: low strength.	Moderate: too sandy.

See footnote at end of table.

TABLE 8.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
HoC2: Hortonville	Moderate: slope.	Severe: low strength.	Moderate: low strength, shrink-swell, slope.	Severe: slope, low strength.	Severe: low strength.	Moderate: slope, too sandy.
HrB: Hortonville	Slight	Severe: low strength.	Moderate: shrink-swell, low strength.	Severe: low strength.	Severe: low strength.	Slight.
HrC2: Hortonville	Moderate: slope.	Severe: low strength.	Moderate: shrink-swell, slope, low strength.	Severe: slope, low strength.	Severe: low strength.	Moderate: slope.
Hu, Hw: Houghton	Severe: wetness, floods, excess humus.	Severe: wetness, floods, low strength.	Severe: wetness, low strength, floods.	Severe: wetness, floods, low strength.	Severe: wetness, frost action, low strength.	Severe: excess humus, wetness, floods.
KaB: Kaukauna	Moderate: too clayey, wetness.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: low strength, shrink-swell.	Moderate: too clayey.
Ke: Keowns	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods, frost action.	Severe: wetness, floods.
KmB: Kewaunee	Moderate: too clayey.	Severe: low strength.	Severe: low strength.	Severe: low strength.	Severe: low strength.	Moderate: too sandy.
KnB: Kewaunee	Moderate: too clayey.	Severe: low strength.	Severe: low strength.	Severe: low strength.	Severe: low strength.	Slight.
KoC2: Kewaunee	Moderate: too clayey, slope.	Severe: low strength.	Severe: low strength.	Severe: slope, low strength.	Severe: low strength.	Moderate: too clayey.
KpB: Kidder	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action, shrink-swell.	Moderate: too sandy.
KpC2: Kidder	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: shrink-swell, slope.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: too sandy, slope.
KrB: Kidder	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, slope.	Moderate: low strength, frost action.	Slight.
KrC2: Kidder	Moderate: slope.	Moderate: shrink-swell, slope.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
Ks: Kingsville	Severe: wetness, cutbanks cave, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
KwB: Knowles	Severe: depth to rock.	Moderate: depth to rock, shrink-swell.	Severe: depth to rock.	Moderate: slope, depth to rock, shrink-swell.	Severe: frost action.	Moderate: thin layer.

See footnote at end of table.

TABLE 8.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
KwC2--------------- Knowles	Severe: depth to rock.	Moderate: slope, depth to rock, shrink-swell.	Severe: depth to rock.	Severe: slope.	Severe: frost action.	Moderate: slope, thin layer.
KyA--------------- Korobago	Severe: wetness, floods.	Severe: floods, wetness, low strength.	Severe: floods, wetness, low strength.	Severe: floods, wetness, low strength.	Severe: low strength, floods, frost action.	Moderate: wetness, floods.
LmA--------------- Lamartine	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods, low strength.	Moderate: wetness, floods.
LrB--------------- LeRoy	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: slope, shrink-swell.	Moderate: frost action.	Slight.
LrC2-------------- LeRoy	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: slope, frost action.	Moderate: slope.
LvB--------------- Lomira	Slight---------	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: frost action, low strength.	Slight.
LzB--------------- Lorenzo Variant	Moderate: too clayey, wetness.	Moderate: wetness, shrink-swell, low strength.	Severe: wetness.	Moderate: wetness, shrink-swell, slope.	Moderate: wetness, frost action.	Moderate: small stones.
MaA--------------- Manawa	Severe: wetness, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: floods, low strength, frost action.	Moderate: wetness, floods, too clayey.
MhB--------------- McHenry	Slight---------	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: slope, shrink-swell.	Moderate: low strength, frost action.	Slight.
MhC2-------------- McHenry	Moderate: slope.	Moderate: slope, shrink-swell.	Moderate: slope, shrink-swell.	Severe: slope.	Moderate: low strength, slope, frost action.	Moderate: slope.
Mn---------------- Menasha	Severe: wetness, floods.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: low strength, wetness, frost action.	Severe: too clayey, wetness, floods.
MoA--------------- Morocco	Severe: cutbanks cave, wetness.	Severe: wetness.	Severe: wetness.	Severe: wetness, frost action.	Moderate: wetness, frost action.	Moderate: too sandy, wetness.
MtA--------------- Mosel	Severe: wetness, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: frost action, floods.	Moderate: floods, wetness.
Na---------------- Navan	Severe: wetness, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, frost action.	Severe: wetness, floods.

See footnote at end of table.

TABLE 8.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
NeA--------------- Nebago	Severe: wetness, cutbanks cave.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Severe: wetness, shrink-swell, low strength.	Moderate: wetness, frost action.	Severe: too sandy.
Ng---------------- Nebago Variant	Severe: wetness, floods.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: low strength, wetness, floods.	Severe: wetness, floods.
NhA--------------- Neenah	Severe: wetness, floods.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: low strength, frost action, floods.	Moderate: wetness, floods, too clayey.
NnA--------------- Nenno	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: low strength, floods, frost action.	Moderate: wetness, floods.
OaB--------------- Oakville	Severe: cutbanks cave.	Slight	Slight	Moderate: slope.	Slight	Severe: too sandy.
OaC--------------- Oakville	Severe: cutbanks cave.	Moderate: slope.	Moderate: slope.	Severe: slope.	Moderate: slope.	Severe: too sandy.
OmB--------------- Omro	Moderate: too clayey.	Severe: low strength.	Severe: low strength.	Severe: low strength.	Severe: low strength.	Moderate: too clayey.
Os---------------- Ossian	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness, frost action.	Severe: floods, wetness.
Pa---------------- Palms	Severe: wetness, excess humus, floods.	Severe: wetness, low strength, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, low strength, frost action.	Severe: wetness, floods, excess humus.
Pg*, Ph*. Pits						
PsB--------------- Plano	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, slope, low strength.	Severe: frost action, low strength.	Slight.
Pt---------------- Poy	Severe: cutbanks cave, wetness, floods.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: low strength, wetness, frost action.	Severe: wetness, floods.
Pu---------------- Poygan	Severe: wetness, floods.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods, low strength.	Severe: wetness, floods.
PzB--------------- Puchyan	Severe: cutbanks cave.	Moderate: low strength.	Moderate: wetness, low strength.	Moderate: slope, low strength.	Moderate: low strength, frost action.	Moderate: too sandy.
RhB--------------- Ritchey	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: thin layer.
RhC2-------------- Ritchey	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.	Severe: thin layer.

See footnote at end of table.

TABLE 8.--BUILDING SITE DEVELOPMENT--Continued

Soil name and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Local roads and streets	Lawns and landscaping
RhD2: Ritchey	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: slope, thin layer.
ScB: St. Charles	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: slope, shrink-swell, low strength.	Severe: frost action, low strength.	Slight.
TuB: Tustin	Moderate: too clayey.	Severe: low strength.	Severe: low strength.	Severe: low strength.	Moderate: frost action.	Severe: too sandy.
UoA*. Udorthents						
We: Wauseon	Severe: wetness, cutbanks cave, floods.	Severe: wetness, low strength, floods.	Severe: wetness, low strength, floods.	Severe: wetness, low strength, floods.	Severe: wetness, frost action, low strength.	Severe: wetness, floods.
WfB: Whalan	Severe: depth to rock.	Moderate: shrink-swell, low strength, depth to rock.	Severe: depth to rock.	Moderate: slope, shrink-swell, depth to rock.	Severe: low strength.	Moderate: thin layer, too sandy.
WhB: Whalan	Severe: depth to rock.	Moderate: shrink-swell, low strength, depth to rock.	Severe: depth to rock.	Moderate: slope, shrink-swell, depth to rock.	Severe: low strength,	Moderate: thin layer.
WhC2: Whalan	Severe: depth to rock.	Moderate: slope, shrink-swell, depth to rock.	Severe: depth to rock.	Severe: slope.	Severe: low strength.	Moderate: slope, thin layer.
Wm: Willette	Severe: excess humus, wetness, floods.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: low strength, wetness, frost action.	Severe: excess humus, wetness, floods.
WnB: Winneconne	Moderate: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: low strength, shrink-swell.	Moderate: too clayey.
YaA: Yahara	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: frost action, floods.	Moderate: wetness, floods.
ZtA: Zittau	Severe: cutbanks cave, wetness, floods.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: low strength, frost action, shrink-swell.	Moderate: too clayey, wetness, floods.

* See map unit description for the composition and behavior of the map unit.

TABLE 9.--SANITARY FACILITIES

[Some of the terms used in this table to describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms used to rate soils. Absence of an entry means soil was not rated]

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Ak: Adrian	Severe: wetness, floods.	Severe: wetness, seepage, excess humus.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Poor: seepage, wetness, excess humus.
AtA: Atterberry	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
BoB: Borth	Severe: wetness, percs slowly.	Severe: seepage, wetness.	Severe: seepage, wetness, too sandy.	Severe: wetness.	Poor: seepage, too sandy.
BrB: Brems	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, too sandy, wetness.	Severe: seepage, wetness.	Poor: too sandy, seepage.
CeB: Casco	Slight*	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Fair: too sandy, seepage.
CeC2: Casco	Moderate:* slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Fair: too sandy, seepage, slope.
Ed: Edwards	Severe: floods, wetness.	Severe: excess humus, wetness, seepage.	Severe: floods, wetness, excess humus.	Severe: floods, wetness, seepage.	Poor: wetness, excess humus.
ElD2: Eleva	Severe: depth to rock.	Severe: slope, seepage.	Severe: depth to rock, seepage.	Severe: seepage.	Poor: area reclaim.
FkA: Fisk	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Poor: seepage, wetness.
Fn**. Fluvaquents					
FsB: Fox	Slight*	Severe: seepage.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
FsC2: Fox	Moderate:* slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
GnB: Grellton	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
HmB: Hochheim	Moderate:*** percs slowly.	Moderate: seepage, slope.	Slight	Slight	Fair: small stones.
HoB: Hortonville	Severe: percs slowly.	Moderate: slope, seepage.	Moderate: too clayey.	Slight	Fair: too clayey.

See footnotes at end of table.

TABLE 9.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
HoC2----------------- Hortonville	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Moderate: slope.	Fair: too clayey, slope.
HrB------------------ Hortonville	Severe: percs slowly.	Moderate: slope, seepage.	Moderate: too clayey.	Slight-----------	Fair: too clayey.
HrC2----------------- Hortonville	Severe: percs slowly.	Severe: slope.	Moderate: too clayey.	Moderate: slope.	Fair: too clayey, slope.
Hu, Hw--------------- Houghton	Severe: wetness, floods.	Severe: wetness, seepage, excess humus.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Poor: excess humus, wetness.
KaB------------------ Kaukauna	Severe: wetness, percs slowly.	Severe: wetness.	Severe: wetness.	Severe: wetness.	Fair: wetness.
Ke------------------- Keowns	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
KmB, KnB------------- Kewaunee	Severe: percs slowly, wetness.	Moderate: slope.	Severe: too clayey.	Slight-----------	Poor: too clayey.
KoC2----------------- Kewaunee	Severe: percs slowly.	Severe: slope.	Severe: too clayey.	Moderate: slope.	Poor: too clayey.
KpB------------------ Kidder	Slight-----------	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: small stones.
KpC2----------------- Kidder	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: small stones, slope.
KrB------------------ Kidder	Slight-----------	Severe: seepage.	Severe: seepage.	Severe: seepage.	Fair: small stones.
KrC2----------------- Kidder	Moderate: slope.	Severe: seepage, slope.	Severe: seepage.	Severe: seepage.	Fair: slope, small stones.
Ks------------------- Kingsville	Severe: wetness, floods.	Severe: wetness, seepage.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Poor: wetness, too sandy, seepage.
KwB------------------ Knowles	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight-----------	Poor: area reclaim.
KwC2----------------- Knowles	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Moderate: slope.	Poor: area reclaim.
KyA------------------ Korobago	Severe: floods, wetness, percs slowly.	Moderate: seepage.	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: too clayey, wetness.
LmA------------------ Lamartine	Severe: wetness, floods.	Severe: wetness, seepage.	Severe: wetness, floods, seepage.	Severe: wetness, floods, seepage.	Poor: wetness.

See footnotes at end of table.

TABLE 9.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
LrB: LeRoy	Slight	Moderate: slope, seepage.	Slight	Slight	Fair: small stones.
LrC2: LeRoy	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.	Fair: small stones, slope.
LvB: Lomira	Slight	Moderate: slope, seepage.	Slight	Slight	Fair: small stones.
LzB: Lorenzo Variant	Severe: wetness, percs slowly.	Severe: seepage.	Severe: too clayey.	Severe: seepage.	Poor: seepage, too clayey.
MaA: Manawa	Severe: wetness, percs slowly, floods.	Slight	Severe: wetness, too clayey, floods.	Severe: wetness, floods.	Poor: too clayey, wetness.
MhB: McHenry	Slight	Severe: seepage.	Severe: seepage.	Slight	Fair: too clayey.
MhC2: McHenry	Moderate: slope.	Severe: slope, seepage.	Severe: seepage.	Moderate: slope.	Fair: slope, too clayey.
Mn: Menasha	Severe: floods, wetness, percs slowly.	Slight	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: too clayey, wetness.
MoA: Morocco	Severe: wetness.	Severe: seepage, wetness.	Severe: seepage, too sandy, wetness.	Severe: seepage, wetness.	Poor: too sandy, wetness, seepage.
MtA: Mosel	Severe: wetness, percs slowly, floods.	Moderate: seepage.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: too clayey, wetness.
Na: Navan	Severe: wetness, percs slowly, floods.	Moderate: seepage.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness, too clayey.
NeA: Nebago	Severe: wetness, percs slowly.	Severe: seepage.	Severe: wetness. too clayey.	Severe: wetness, seepage.	Poor: wetness, too clayey.
Ng: Nebago Variant	Severe: floods, wetness, percs slowly.	Severe: seepage, wetness.	Severe: floods, seepage, wetness.	Severe: floods, seepage, wetness.	Poor: seepage, too clayey, wetness.
NhA: Neenah	Severe: floods, wetness, percs slowly.	Slight	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: too clayey, wetness.
NnA: Nenno	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.

See footnotes at end of table.

TABLE 9.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
OaB: Oakville	Slight*	Severe: seepage.	Severe: seepage, too sandy, seepage.	Severe: seepage.	Poor: too sandy, seepage.
OaC: Oakville	Moderate:* slope.	Severe: seepage, slope.	Severe: seepage, too sandy.	Severe: seepage.	Poor: too sandy, seepage.
OmB: Omro	Severe: percs slowly.	Moderate: seepage, slope.	Slight	Slight	Fair: small stones.
Os: Ossian	Severe: floods, wetness.	Severe: wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.
Pa: Palms	Severe: wetness, floods, subsides.	Severe: wetness, seepage, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, floods, seepage.	Poor: wetness, excess humus.
Pg**: Ph**. Pits					
PsB: Plano	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
Pt: Poy	Severe: floods, wetness, percs slowly.	Severe: seepage, wetness.	Severe: floods, seepage, wetness.	Severe: floods, wetness.	Poor: seepage, too sandy, wetness.
Pu: Poygan	Severe: wetness, percs slowly, floods.	Slight	Severe: wetness, floods, too clayey.	Severe: wetness, floods.	Poor: wetness, too clayey.
PzB: Puchyan	Severe: wetness.	Severe: seepage, wetness.	Severe: wetness.	Severe: seepage, wetness.	Fair: wetness.
RhB: Ritchey	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight	Poor: area reclaim.
RhC2: Ritchey	Severe: depth to rock.	Severe: depth to rock, slope.	Severe: depth to rock.	Moderate: slope.	Poor: area reclaim.
RhD2: Ritchey	Severe: depth to rock, slope.	Severe: depth to rock, slope.	Severe: depth to rock.	Severe: slope.	Poor: area reclaim, slope.
ScB: St. Charles	Slight	Moderate: seepage, slope.	Moderate: too clayey.	Slight	Fair: too clayey.
TuB: Tustin	Severe: percs slowly.	Severe: seepage.	Severe: too clayey.	Severe: seepage.	Poor: too clayey.
UoA**. Udorthents					
We: Wauseon	Severe: percs slowly, wetness, floods.	Severe: seepage.	Severe: wetness, too clayey, floods.	Severe: wetness, seepage.	Poor: wetness, too clayey.
WfB, WhB: Whalan	Severe: depth to rock.	Severe: depth to rock.	Severe: depth to rock.	Slight	Poor: area reclaim.

See footnotes at end of table.

TABLE 9.--SANITARY FACILITIES--Continued

Soil name and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
WhC2: Whalan	Severe: depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock.	Moderate: slope.	Poor: area reclaim.
Wm: Willette	Severe: floods, wetness, percs slowly.	Severe: excess humus, seepage.	Severe: floods, wetness, too clayey.	Severe: floods, seepage, wetness.	Poor: wetness, too clayey, excess humus.
WnB: Winneconne	Severe: wetness, percs slowly.	Moderate: slope.	Severe: too clayey.	Slight	Poor: too clayey.
YaA: Yahara	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
ZtA: Zittau	Severe: floods, wetness, percs slowly.	Severe: seepage, wetness.	Severe: floods, seepage, wetness.	Severe: floods, wetness.	Poor: seepage, too sandy, wetness.

* Excessive permeability rate may cause pollution of ground water.

** See map unit description for the composition and behavior of the map unit.

*** Where permeability is moderately slow, rate severe, percs slowly and wetness.

TABLE 10.--CONSTRUCTION MATERIALS

[Some of the terms used in this table to describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," or "poor." Absence of an entry means soil was not rated]

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Ak: Adrian	Poor: wetness.	Fair: excess fines.	Unsuited: excess fines.	Poor: wetness, excess humus.
AtA: Atterberry	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
BoB: Borth	Fair: wetness.	Fair: excess fines.	Unsuited: excess fines.	Fair: too clayey, thin layer.
BrB: Brems	Fair: wetness.	Fair: excess fines.	Unsuited: excess fines.	Poor: too sandy.
CeB: Casco	Good	Good	Good	Fair: thin layer.
CeC2: Casco	Good	Good	Good	Fair: thin layer, slope.
Ed: Edwards	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness, excess humus.
ElD2: Eleva	Poor: area reclaim, thin layer.	Poor: excess fines.	Unsuited: excess fines.	Fair: slope, area reclaim.
FkA: Fisk	Poor: wetness.	Poor: excess fines, thin layer.	Unsuited: excess fines.	Fair: too sandy.
Fn*. Fluvaquents				
FsB: Fox	Good	Good	Good	Fair: thin layer.
FsC2: Fox	Good	Good	Good	Fair: thin layer, slope.
GnB: Grellton	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
HmB: Hochheim	Fair: low strength.	Poor: excess fines.	Unsuited: excess fines.	Poor: thin layer, small stones.
HoB: Hortonville	Fair: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too sandy.
HoC2: Hortonville	Fair: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too sandy, slope.
HrB: Hortonville	Fair: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.

See footnote at end of table.

TABLE 10.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
HrC2: Hortonville	Fair: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, slope.
Hu, Hw: Houghton	Poor: wetness, low strength.	Unsuited: excess humus.	Unsuited: excess humus.	Poor: wetness, excess humus.
KaB: Kaukauna	Fair: low strength, wetness.	Poor: excess fines.	Unsuited: excess fines.	Fair: too clayey, thin layer.
Ke: Keowns	Poor: wetness.	Poor: excess fines.	Unsuited: excess fines.	Poor: wetness.
KmB: Kewaunee	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too sandy, thin layer.
KnB: Kewaunee	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
KoC2: Kewaunee	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey, slope.
KpB: Kidder	Good	Poor: excess fines.	Unsuited: excess fines.	Fair: too sandy, thin layer.
KpC2: Kidder	Good	Poor: excess fines.	Unsuited: excess fines.	Fair: too sandy, thin layer, slope.
KrB: Kidder	Good	Poor: excess fines.	Unsuited: excess fines.	Fair: thin layer.
KrC2: Kidder	Good	Poor: excess fines.	Unsuited: excess fines.	Fair: thin layer, slope.
Ks: Kingsville	Poor: wetness.	Fair: excess fines.	Unsuited: excess fines.	Poor: wetness.
KwB: Knowles	Poor: area reclaim, thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, area reclaim.
KwC2: Knowles	Poor: area reclaim, thin layer.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: slope, thin layer, area reclaim.
KyA: Korobago	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
LmA: Lamartine	Poor: wetness.	Poor: excess fines.	Poor: excess fines.	Fair: thin layer.
LrB: LeRoy	Fair: low strength.	Poor: excess fines.	Poor: excess fines.	Fair: thin layer.
LrC2: LeRoy	Fair: low strength.	Poor: excess fines.	Poor: excess fines.	Fair: slope, thin layer.

See footnote at end of table.

TABLE 10.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
LvB: Lomira	Fair: low strength.	Poor: excess fines.	Poor: excess fines.	Fair: thin layer.
LzB: Lorenzo Variant	Poor: low strength.	Poor: excess fines, thin layer.	Poor: thin layer.	Fair: small stones, thin layer.
MaA: Manawa	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: too clayey.
MhB: McHenry	Good	Poor: excess fines.	Unsuited: excess fines.	Fair: thin layer.
MhC2: McHenry	Good	Poor: excess fines.	Unsuited: excess fines.	Fair: slope, thin layer.
Mn: Menasha	Poor: low strength, wetness, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: too clayey, thin layer, wetness.
MoA: Morocco	Poor: wetness.	Fair: excess fines.	Unsuited: excess fines.	Fair: too sandy.
MtA: Mosel	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Na: Navan	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
NeA: Nebago	Poor: low strength, wetness, shrink-swell.	Poor: thin layer.	Unsuited: excess fines.	Poor: too sandy.
Ng: Nebago Variant	Poor: wetness, low strength, shrink-swell.	Fair: excess fines.	Unsuited: excess fines.	Poor: thin layer, wetness.
NhA: Neenah	Poor: low strength, wetness, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer.
NnA: Nenno	Poor: wetness.	Poor: excess fines.	Unsuited: excess fines.	Fair: thin layer, small stones.
OaB, OaC: Oakville	Good	Fair: excess fines.	Unsuited: excess fines.	Poor: too sandy.
OmB: Omro	Poor: low strength.	Poor: excess fines.	Unsuited: excess fines.	Fair: thin layer, too clayey.
Os: Ossian	Poor: wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
Pa: Palms	Poor: wetness, low strength.	Unsuited: excess humus, excess fines.	Unsuited: excess humus, excess fines.	Poor: wetness, excess humus.

See footnote at end of table.

TABLE 10.--CONSTRUCTION MATERIALS--Continued

Soil name and map symbol	Roadfill	Sand	Gravel	Topsoil
Pg*, Ph*. Pits				
PsB-------------------- Plano	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
Pt--------------------- Poy	Poor: wetness.	Fair: excess fines.	Unsuited: excess fines.	Poor: wetness.
Pu--------------------- Poygan	Poor: wetness, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness.
PzB-------------------- Puchyan	Fair: low strength, wetness.	Poor: thin layer, excess fines.	Unsuited: excess fines.	Fair: too sandy.
RhB, RhC2-------------- Ritchey	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: area reclaim, thin layer.
RhD2------------------- Ritchey	Poor: thin layer, area reclaim.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer, slope.
ScB-------------------- St. Charles	Poor: low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer.
TuB-------------------- Tustin	Poor: low strength.	Poor: thin layer, excess fines.	Unsuited: excess fines.	Poor: too sandy.
UoA*. Udorthents				
We--------------------- Wauseon	Poor: wetness, low strength.	Poor: excess fines, thin layer.	Unsuited: excess fines.	Poor: wetness.
WfB, WhB--------------- Whalan	Poor: thin layer, area reclaim, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: thin layer, area reclaim.
WhC2------------------- Whalan	Poor: thin layer, area reclaim, low strength.	Unsuited: excess fines.	Unsuited: excess fines.	Fair: slope, thin layer, area reclaim.
Wm--------------------- Willette	Poor: low strength, wetness.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: wetness, excess humus.
WnB-------------------- Winneconne	Poor: low strength, shrink-swell.	Unsuited: excess fines.	Unsuited: excess fines.	Poor: thin layer.
YaA-------------------- Yahara	Poor: wetness.	Poor: excess fines.	Unsuited: excess fines.	Good.
ZtA-------------------- Zittau	Poor: wetness.	Fair: excess fines.	Unsuited: excess fines.	Fair: too clayey.

* See map unit description for the composition and behavior of the map unit.

TABLE 11.--WATER MANAGEMENT

[Some of the terms used in this table to describe restrictive soil features are defined in the Glossary. Absence of an entry means soil was not evaluated]

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
Ak: Adrian	Seepage	Seepage, wetness, piping.	Favorable	Floods, frost action, excess humus.	Not needed	Wetness.
AtA: Atterberry	Seepage	Hard to pack, wetness.	Slow refill, deep to water.	Frost action	Not needed	Wetness, erodes easily.
BoB: Borth	Seepage	Seepage	Deep to water	Not needed	Percs slowly	Erodes easily, percs slowly.
BrB: Brems	Seepage	Seepage, piping.	Deep to water	Not needed	Wetness, too sandy, soil blowing.	Droughty.
CeB: Casco	Seepage	Seepage	No water	Not needed	Too sandy	Droughty.
CeC2: Casco	Seepage, slope.	Seepage	No water	Not needed	Too sandy	Droughty, slope.
Ed: Edwards	Seepage	Excess humus, wetness.	Favorable	Frost action, floods, excess humus.	Not needed	Wetness.
ElD2: Eleva	Slope, seepage.	Thin layer, seepage, piping.	No water	Not needed	Slope, depth to rock.	Slope, depth to rock.
FkA: Fisk	Seepage	Piping, wetness.	Slow refill	Frost action	Not needed	Wetness, erodes easily.
Fn*. Fluvaquents						
FsB: Fox	Seepage	Seepage	No water	Not needed	Too sandy	Favorable.
FsC2: Fox	Seepage, slope.	Seepage	No water	Not needed	Too sandy	Slope.
GnB: Grellton	Seepage	Favorable	No water	Not needed	Soil blowing	Favorable.
HmB: Hochheim	Seepage	Seepage	No water	Not needed	Favorable	Favorable.
HoB: Hortonville	Seepage	Favorable	No water	Not needed	Soil blowing	Erodes easily.
HoC2: Hortonville	Seepage, slope.	Favorable	No water	Not needed	Soil blowing	Slope, erodes easily.
HrB: Hortonville	Seepage	Favorable	No water	Not needed	Favorable	Erodes easily.
HrC2: Hortonville	Slope, seepage.	Favorable	No water	Not needed	Favorable	Slope, erodes easily.
Hu, Hw: Houghton	Seepage	Excess humus, wetness.	Favorable	Frost action, excess humus, floods.	Not needed	Wetness.
KaB: Kaukauna	Seepage	Piping	Deep to water, slow refill.	Not needed	Percs slowly	Erodes easily, percs slowly.
Ke: Keowns	Seepage	Wetness, piping, seepage.	Slow refill	Floods, frost action.	Not needed	Wetness.

See footnote at end of table.

TABLE 11.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
KmB: Kewaunee	Favorable	Hard to pack	Deep to water, slow refill.	Not needed	Soil blowing, percs slowly.	Erodes easily, percs slowly.
KnB: Kewaunee	Favorable	Hard to pack	Deep to water, slow refill.	Not needed	Percs slowly	Erodes easily, percs slowly.
KoC2: Kewaunee	Slope	Hard to pack	No water	Not needed	Percs slowly	Slope, erodes easily, percs slowly.
KpB: Kidder	Seepage	Seepage	No water	Not needed	Soil blowing	Favorable.
KpC2: Kidder	Seepage, slope.	Seepage	No water	Not needed	Soil blowing	Slope.
KrB: Kidder	Seepage	Seepage	No water	Not needed	Favorable	Favorable.
KrC2: Kidder	Seepage, slope.	Seepage	No water	Not needed	Favorable	Slope.
Ks: Kingsville	Seepage	Seepage, wetness.	Favorable	Floods	Not needed	Wetness, droughty.
KwB: Knowles	Depth to rock, seepage.	Thin layer	No water	Not needed	Erodes easily, depth to rock.	Depth to rock, erodes easily.
KwC2: Knowles	Depth to rock, seepage, slope.	Thin layer	No water	Not needed	Erodes easily, depth to rock.	Slope, depth to rock, erodes easily.
KyA: Korobago	Seepage	Hard to pack, wetness.	Deep to water, slow refill.	Percs slowly, floods, frost action.	Not needed	Wetness, erodes easily, percs slowly.
LmA: Lamartine	Seepage	Seepage, wetness.	Deep to water, slow refill.	Frost action, floods.	Not needed	Wetness, erodes easily.
LrB: LeRoy	Seepage	Seepage	No water	Not needed	Favorable	Erodes easily.
LrC2: LeRoy	Seepage, slope.	Seepage	No water	Not needed	Favorable	Slope, erodes easily.
LvB: Lomira	Seepage	Seepage	No water	Not needed	Favorable	Erodes easily.
LzB: Lorenzo Variant	Seepage	Wetness	Deep to water, slow refill.	Percs slowly	Wetness, percs slowly.	Percs slowly.
MaA: Manawa	Favorable	Hard to pack, wetness.	Slow refill, deep to water.	Percs slowly, floods, frost action.	Not needed	Wetness, erodes easily, percs slowly.
MhB: McHenry	Seepage	Seepage	No water	Not needed	Favorable	Erodes easily.
MhC2: McHenry	Slope, seepage.	Seepage	No water	Not needed	Favorable	Erodes easily, slope.
Mn: Menasha	Favorable	Hard to pack, wetness.	Slow refill	Percs slowly, floods, frost action.	Not needed	Wetness, percs slowly.
MoA: Morocco	Seepage	Seepage, piping, wetness.	Deep to water	Favorable	Not needed	Wetness, droughty.

See footnote at end of table.

TABLE 11.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
MtA Mosel	Seepage	Wetness, hard to pack.	Slow refill	Frost action, percs slowly, floods.	Not needed	Wetness, percs slowly.
Na Navan	Seepage	Wetness, hard to pack.	Slow refill	Percs slowly, floods, frost action.	Not needed	Wetness, percs slowly.
NeA Nebago	Seepage	Hard to pack, wetness.	Slow refill	Percs slowly	Not needed	Wetness, percs slowly.
Ng Nebago Variant	Seepage	Hard to pack, wetness.	Favorable	Percs slowly, floods.	Not needed	Wetness, droughty, percs slowly.
NhA Neenah	Favorable	Hard to pack, wetness.	Deep to water, slow refill.	Percs slowly, floods, frost action.	Not needed	Wetness, percs slowly.
NnA Nenno	Seepage	Seepage, wetness.	Slow refill	Frost action, floods.	Not needed	Wetness.
OaB Oakville	Seepage	Piping, seepage.	No water	Not needed	Too sandy, soil blowing.	Droughty.
OaC Oakville	Seepage, slope.	Piping, seepage.	No water	Not needed	Too sandy, soil blowing.	Slope, droughty.
OmB Omro	Seepage	Hard to pack	No water	Not needed	Percs slowly	Percs slowly.
Os Ossian	Seepage	Wetness	Slow refill	Floods, frost action.	Not needed	Wetness.
Pa Palms	Seepage	Excess humus, wetness.	Favorable	Floods, frost action, excess humus.	Not needed	Wetness.
Pg*, Ph*. Pits						
PsB Plano	Seepage	Favorable	No water	Not needed	Erodes easily	Erodes easily.
Pt Poy	Seepage	Seepage, wetness.	Favorable	Percs slowly, floods, frost action.	Not needed	Wetness, percs slowly.
Pu Poygan	Favorable	Hard to pack, wetness.	Slow refill	Percs slowly, floods, frost action.	Not needed	Wetness, percs slowly, erodes easily.
PzB Puchyan	Seepage	Favorable	Deep to water, slow refill.	Not needed	Too sandy, soil blowing.	Favorable.
RhB Ritchey	Depth to rock	Thin layer	No water	Not needed	Depth to rock	Rooting depth, erodes easily.
RhC2 Ritchey	Slope, depth to rock.	Thin layer	No water	Not needed	Depth to rock	Rooting depth, erodes easily, slope.
RhD2 Ritchey	Slope, depth to rock.	Thin layer	No water	Not needed	Slope, depth to rock.	Rooting depth, erodes easily, slope.
ScB St. Charles	Seepage	Favorable	No water	Not needed	Favorable	Erodes easily.

See footnote at end of table.

TABLE 11.--WATER MANAGEMENT--Continued

Soil name and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Aquifer-fed excavated ponds	Drainage	Terraces and diversions	Grassed waterways
TuB---------------- Tustin	Seepage--------	Hard to pack---	No water-------	Not needed-----	Too sandy, soil blowing, percs slowly.	Percs slowly.
UoA*. Udorthents						
We----------------- Wauseon	Seepage--------	Wetness, hard to pack.	Favorable------	Percs slowly, frost action, floods.	Not needed-----	Wetness, percs slowly.
WfB---------------- Whalan	Depth to rock, seepage.	Thin layer-----	No water-------	Not needed-----	Depth to rock, soil blowing.	Depth to rock.
WhB---------------- Whalan	Depth to rock, seepage.	Thin layer-----	No water-------	Not needed-----	Depth to rock	Depth to rock.
WhC2--------------- Whalan	Slope, depth to rock, seepage.	Thin layer-----	No water-------	Not needed-----	Depth to rock	Slope, depth to rock.
Wm----------------- Willette	Seepage--------	Excess humus, wetness.	Favorable------	Frost action, floods, excess humus.	Not needed-----	Wetness.
WnB---------------- Winneconne	Favorable------	Hard to pack---	Deep to water, slow refill.	Percs slowly---	Percs slowly---	Percs slowly.
YaA---------------- Yahara	Seepage--------	Piping, wetness, seepage.	Slow refill, deep to water.	Frost action, floods.	Not needed-----	Wetness, erodes easily.
ZtA---------------- Zittau	Seepage--------	Seepage, wetness.	Deep to water	Percs slowly, floods, frost action.	Not needed-----	Wetness, percs slowly.

* See map unit description for the composition and behavior of the map unit.

TABLE 12.--RECREATIONAL DEVELOPMENT

[Some of the terms used in this table to describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry means soil was not rated]

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
Ak: Adrian	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.	Severe: excess humus, floods, wetness.
AtA: Atterberry	Severe: wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness.
BoB: Borth	Severe: percs slowly.	Moderate: too clayey.	Severe: percs slowly.	Moderate: too clayey.	Moderate: too clayey.
BrB: Brems	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
CeB: Casco	Slight	Slight	Moderate: slope.	Slight	Slight.
CeC2: Casco	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Ed: Edwards	Severe: floods, wetness, excess humus.	Severe: wetness, excess humus.	Severe: excess humus, wetness, floods.	Severe: wetness, excess humus.	Severe: excess humus, wetness, floods.
ElD2: Eleva	Severe: slope.	Severe: slope.	Severe: slope.	Moderate: slope.	Severe: slope.
FkA: Fisk	Severe: wetness.	Moderate: wetness, too sandy.	Severe: wetness.	Moderate: wetness, too sandy.	Moderate: too sandy, wetness.
Fn*. Fluvaquents					
FsB: Fox	Slight	Slight	Moderate: slope.	Slight	Slight.
FsC2: Fox	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
GnB: Grellton	Slight	Slight	Moderate: slope.	Slight	Slight.
HmB: Hochheim	Slight	Slight	Moderate: slope.	Slight	Slight.
HoB: Hortonville	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.	Moderate: too sandy.
HoC2: Hortonville	Moderate: too sandy, slope.	Moderate: too sandy, slope.	Severe: slope.	Moderate: too sandy.	Moderate: slope, too sandy.
HrB: Hortonville	Moderate: percs slowly.	Slight	Moderate: slope, percs slowly.	Slight	Slight.
HrC2: Hortonville	Moderate: slope, percs slowly.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.

See footnote at end of table.

TABLE 12.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
Hu, Hw Houghton	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.	Severe: excess humus, wetness, floods.
KaB Kaukauna	Severe: percs slowly.	Moderate: too clayey.	Severe: percs slowly.	Moderate: too clayey.	Moderate: too clayey.
Ke Keowns	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.
KmB Kewaunee	Moderate: percs slowly, too sandy.	Moderate: too sandy.	Moderate: slope, too sandy, percs slowly.	Moderate: too sandy.	Moderate: too sandy.
KnB Kewaunee	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight	Slight.
KoC2 Kewaunee	Moderate: percs slowly, too clayey.	Moderate: too clayey.	Severe: slope.	Moderate: too clayey.	Moderate: too clayey.
KpB Kidder	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.	Moderate: too sandy.
KpC2 Kidder	Moderate: slope, too sandy.	Moderate: slope, too sandy.	Severe: slope.	Moderate: too sandy.	Moderate: too sandy, slope.
KrB Kidder	Slight	Slight	Moderate: slope.	Slight	Slight.
KrC2 Kidder	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
Ks Kingsville	Severe: floods, wetness.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.
KwB Knowles	Slight	Slight	Moderate: slope, depth to rock.	Slight	Moderate: thin layer.
KwC2 Knowles	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope, thin layer.
KyA Korobago	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, floods.
LmA Lamartine	Severe: wetness, floods.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, floods.
LrB LeRoy	Slight	Slight	Moderate: slope.	Slight	Slight.
LrC2 LeRoy	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope.
LvB Lomira	Slight	Slight	Moderate: slope.	Slight	Slight.
LzB Lorenzo Variant	Severe: percs slowly.	Moderate: wetness.	Severe: percs slowly.	Slight	Moderate: small stones.

See footnote at end of table.

TABLE 12.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
MaA------------------- Manawa	Severe: floods, wetness.	Moderate: wetness, too clayey.	Severe: wetness.	Moderate: wetness, too clayey.	Moderate: wetness, floods.
MhB------------------- McHenry	Slight----------	Slight----------	Moderate: slope.	Slight------------	Slight.
MhC2------------------ McHenry	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight------------	Moderate: slope.
Mn-------------------- Menasha	Severe: floods, wetness, percs slowly.	Severe: wetness, too clayey.	Severe: too clayey, wetness, floods.	Severe: wetness, too clayey.	Severe: too clayey, wetness, floods.
MoA------------------- Morocco	Severe: wetness.	Moderate: wetness, too sandy.	Severe: wetness.	Moderate: wetness, too sandy.	Moderate: too sandy, wetness.
MtA------------------- Mosel	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: floods, wetness.
Na-------------------- Navan	Severe: floods, wetness.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.
NeA------------------- Nebago	Severe: wetness, too sandy.	Severe: too sandy.	Severe: too sandy, wetness.	Severe: too sandy.	Severe: too sandy.
Ng-------------------- Nebago Variant	Severe: floods, wetness.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.
NhA------------------- Neenah	Severe: floods, wetness, percs slowly.	Moderate: wetness, too clayey.	Severe: wetness, percs slowly.	Moderate: wetness, too clayey.	Moderate: wetness, floods, too clayey.
NnA------------------- Nenno	Severe: wetness, floods.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, floods.
OaB------------------- Oakville	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
OaC------------------- Oakville	Severe: too sandy.	Severe: too sandy.	Severe: slope, too sandy.	Severe: too sandy.	Severe: too sandy.
OmB------------------- Omro	Moderate: percs slowly, too clayey.	Moderate: too clayey.	Moderate: slope, too clayey, percs slowly.	Moderate: too clayey.	Moderate: too clayey.
Os-------------------- Ossian	Severe: floods, wetness.	Severe: wetness.	Severe: floods, wetness.	Severe: wetness.	Severe: floods, wetness.
Pa-------------------- Palms	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.	Severe: wetness, floods, excess humus.	Severe: wetness, excess humus.	Severe: wetness, floods, excess humus.
Pg*, Ph*. Pits					

See footnote at end of table.

TABLE 12.--RECREATIONAL DEVELOPMENT--Continued

Soil name and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails	Golf fairways
PsB: Plano	Slight	Slight	Moderate: slope.	Slight	Slight.
Pt: Poy	Severe: floods, wetness, percs slowly.	Severe: wetness.	Severe: wetness, floods, percs slowly.	Severe: wetness.	Severe: wetness, floods.
Pu: Poygan	Severe: floods, wetness, percs slowly.	Severe: wetness.	Severe: wetness, floods.	Severe: wetness.	Severe: wetness, floods.
PzB: Puchyan	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy.	Moderate: too sandy.	Moderate: too sandy.
RhB: Ritchey	Slight	Slight	Severe: depth to rock.	Slight	Severe: thin layer.
RhC2: Ritchey	Moderate: slope.	Moderate: slope.	Severe: depth to rock, slope.	Slight	Severe: thin layer.
RhD2: Ritchey	Severe: slope.	Severe: slope.	Severe: depth to rock, slope.	Moderate: slope.	Severe: thin layer, slope.
ScB: St. Charles	Slight	Slight	Moderate: slope.	Slight	Slight.
TuB: Tustin	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.	Severe: too sandy.
UoA*. Udorthents					
We: Wauseon	Severe: wetness, percs slowly, floods.	Severe: wetness.	Severe: wetness, percs slowly, floods.	Severe: wetness.	Severe: wetness, floods.
WfB: Whalan	Moderate: too sandy.	Moderate: too sandy.	Moderate: slope, too sandy, depth to rock.	Moderate: too sandy.	Moderate: too sandy, thin layer.
WhB: Whalan	Slight	Slight	Moderate: depth to rock, slope.	Slight	Moderate: thin layer.
WhC2: Whalan	Moderate: slope.	Moderate: slope.	Severe: slope.	Slight	Moderate: slope, thin layer.
Wm: Willette	Severe: floods, wetness, excess humus.	Severe: wetness, excess humus.	Severe: excess humus, wetness, floods.	Severe: wetness, excess humus.	Severe: excess humus, wetness, floods.
WnB: Winneconne	Severe: percs slowly.	Moderate: too clayey.	Severe: percs slowly.	Moderate: too clayey.	Moderate: too clayey.
YaA: Yahara	Severe: floods, wetness.	Moderate: wetness.	Severe: wetness.	Moderate: wetness.	Moderate: wetness, floods.
ZtA: Zittau	Severe: floods, wetness, percs slowly.	Moderate: wetness, too clayey.	Severe: wetness, percs slowly.	Moderate: too clayey, wetness.	Moderate: too clayey, wetness, floods.

* See map unit description for the composition and behavior of the map unit.

TABLE 13.--WILDLIFE HABITAT POTENTIALS

[See text for definitions of "good," "fair," "poor," and "very poor." Absence of an entry indicates the soil was not rated]

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
Ak----- Adrian	Good	Poor	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
AtA----- Atterberry	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
BoB----- Borth	Good	Good	Good	Good	Good	Poor	Fair	Good	Good	Poor.
BrB----- Brems	Poor	Poor	Fair	Poor	Poor	Poor	Very poor.	Poor	Poor	Poor.
CeB, CeC2----- Casco	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Ed----- Edwards	Good	Poor	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
ElD2----- Eleva	Fair	Fair	Fair	Fair	Fair	Very poor.	Very poor.	Fair	Fair	Very poor.
FkA----- Fisk	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Fn*. Fluvaquents										
FsB, FsC2----- Fox	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
GnB----- Grellton	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
HmB----- Hochheim	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
HoB, HoC2, HrB, HrC2----- Hortonville	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Hu----- Houghton	Good	Poor	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
Hw----- Houghton	Poor	Poor	Poor	Poor	Poor	Good	Good	Poor	Poor	Good.
KaB----- Kaukauna	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
Ke----- Keowns	Good	Fair	Fair	Fair	Fair	Good	Good	Good	Good	Good.
KmB, KnB, KoC2----- Kewaunee	Good	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
KpB, KpC2, KrB, KrC2----- Kidder	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Ks----- Kingsville	Fair	Fair	Fair	Fair	Fair	Good	Good	Fair	Fair	Good.
KwB, KwC2----- Knowles	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.

See footnote at end of table.

TABLE 13.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
KyA: Korobago	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good.
LmA: Lamartine	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
LrB, LrC2: LeRoy	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
LvB: Lomira	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
LzB: Lorenzo Variant	Fair	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
MaA: Manawa	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good.
MhB: McHenry	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
MhC2: McHenry	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Mn: Menasha	Fair	Fair	Fair	Good	Fair	Good	Good	Fair	Good	Good.
MoA: Morocco	Poor	Fair	Good	Fair	Fair	Fair	Very poor.	Fair	Fair	Poor.
MtA: Mosel	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good.
Na: Navan	Good	Good	Fair	Good	Good	Good	Good	Good	Good	Good.
NeA: Nebago	Fair	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
Ng: Nebago Variant	Fair	Good	Good	Good	Good	Good	Fair	Good	Good	Fair.
NhA: Neenah	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good.
NnA: Nenno	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
OaB: Oakville	Poor	Poor	Fair	Fair	Fair	Very Poor.	Very poor.	Poor	Fair	Very poor.
OaC: Oakville	Poor	Poor	Fair	Fair	Fair	Very poor.	Very poor.	Poor	Fair	Very poor.
OmB: Omr	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Os: Ossian	Good	Good	Good	Fair	Fair	Good	Good	Good	Fair	Good.
Pa: Palms	Good	Poor	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
Pg*, Ph*. Pits										

See footnote at end of table.

TABLE 13.--WILDLIFE HABITAT POTENTIALS--Continued

Soil name and map symbol	Potential for habitat elements							Potential as habitat for--		
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife
PsB----------------- Plano	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
Pt------------------ Poy	Good	Good	Good	Good	Good	Good	Fair	Good	Good	Fair.
Pu------------------ Poygan	Good	Good	Good	Good	Good	Good	Good	Good	Good	Good.
PzB----------------- Puchyan	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
RhB, RhC2, RhD2----- Ritchey	Poor	Poor	Fair	Poor	Poor	Very poor.	Very poor.	Poor	Poor	Very poor.
ScB----------------- St. Charles	Good	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
TuB----------------- Tustin	Fair	Good	Good	Good	Good	Very poor.	Very poor.	Good	Good	Very poor.
UoA*. Udorthents										
We------------------ Wauseon	Good	Poor	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
WfB, WhB, WhC2------ Whalan	Fair	Good	Good	Good	Good	Poor	Very poor.	Good	Good	Very poor.
Wm------------------ Willette	Good	Poor	Poor	Poor	Poor	Good	Good	Fair	Poor	Good.
WnB----------------- Winneconne	Good	Good	Good	Good	Good	Poor	Poor	Good	Good	Poor.
YaA----------------- Yahara	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.
ZtA----------------- Zittau	Good	Good	Good	Good	Good	Fair	Fair	Good	Good	Fair.

* See map unit description for the composition and behavior of the map unit.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS

[The symbol < means less than; > means greater than. Absence of an entry means data were not estimated]

Soil name and map symbol	Depth	USDA texture	Classification		Fragments > 3 inches	Percentage passing sieve number--				Liquid limit	Plasticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
Ak----------------- Adrian	0-22	Sapric material	PT	A-8	---	---	---	---	---	---	---
	22-60	Sand, loamy sand, fine sand.	SP, SM, SP-SM	A-2, A-3, A-1	0	80-100	60-100	35-100	0-30	---	NP
AtA---------------- Atterberry	0-13	Silt loam--------	CL-ML, ML, CL	A-4, A-6	0	100	100	95-100	95-100	20-40	3-15
	13-42	Silty clay loam	CL, CH	A-7, A-6	0	100	100	95-100	95-100	35-55	20-35
	42-60	Silt loam--------	CL	A-6, A-4	0	100	100	95-100	95-100	25-40	10-20
BoB---------------- Borth	0-8	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	90-100	25-70	15-50
	8-30	Silty clay, clay, silty clay loam.	CH	A-7	0	100	100	95-100	90-100	55-90	30-60
	30-60	Sand, fine sand, loamy sand.	SM, SP-SM	A-2, A-3	0	85-100	85-100	60-100	5-35	---	NP
BrB---------------- Brems	0-8	Fine sand--------	SM, SP-SM	A-2-4, A-3	0	100	85-100	50-100	5-15	---	NP
	8-60	Sand, fine sand, loamy sand.	SM, SP-SM	A-3, A-2-4	0	100	80-100	50-100	5-25	---	NP
CeB, CeC2---------- Casco	0-7	Loam-------------	ML, CL-ML, CL	A-4	0	95-100	90-100	75-100	50-90	20-30	3-10
	7-15	Clay loam, loam, sandy clay loam.	SC, CL	A-6, A-7	0-5	60-100	55-100	55-90	35-70	25-45	11-25
	15-60	Sand and gravel	GP, SP, GP-GM, SP-SM	A-1, A-3, A-2	0-10	30-100	30-90	10-90	3-10	---	NP
Ed----------------- Edwards	0-23	Sapric material	PT	A-8	0	---	---	---	---	---	---
	23-60	Marl-------------	---	---	0	100	95-100	80-90	60-80	---	---
ElD2--------------- Eleva	0-5	Loam-------------	ML, CL-ML	A-4	0-2	100	95-100	85-95	50-65	20-30	2-8
	5-10	Loam, sandy loam, fine sandy loam.	ML, CL, CL-ML, SM, SM-SC	A-2, A-4, A-6	0-2	100	90-100	60-95	25-65	<40	NP-15
	10-21	Sand, fine sand, loamy sand.	SM, SP-SM	A-2, A-3	0	100	80-100	50-100	5-35	<20	NP-4
	21-60	Weathered bedrock.	---	---	---	---	---	---	---	---	---
FkA---------------- Fisk	0-24	Loamy fine sand	SM	A-2	0	100	100	80-100	15-30	---	NP
	24-27	Fine sandy loam, loam, sandy loam.	SM, SM-SC, ML, CL-ML	A-2, A-4	0	100	100	80-100	30-75	<25	2-9
	27-39	Silt loam, loam, very fine sandy loam.	ML, CL-ML	A-4	0	100	100	90-100	50-90	<25	2-9
	39-60	Stratified silt loam to very fine sandy loam.	ML	A-4	0	100	100	90-100	50-90	<20	NP-4
Fn*. Fluvaquents											

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
FsB, FsC2---------- Fox	0-11	Silt loam-------	ML, CL, CL-ML	A-4	0	95-100	85-100	75-95	55-90	20-30	3-10
	11-19	Silty clay loam, silt loam, clay loam.	CL	A-6, A-7	0	85-100	75-100	70-95	55-90	25-50	10-25
	19-31	Clay loam, loam, sandy clay loam.	CL, SC	A-2, A-6, A-7	0-5	85-100	75-95	50-95	20-65	25-45	10-25
	31-60	Sand and gravel	SP, SM, GP, GM	A-1, A-2, A-3	0-10	40-100	35-100	15-95	2-20	---	NP
GnB---------------- Grellton	0-13	Fine sandy loam	SM, ML, SM-SC, CL-ML	A-2, A-4	0	100	100	60-100	30-55	<20	2-7
	13-24	Loam, sandy loam, sandy clay loam.	SC, CL	A-4, A-6	0	100	100	70-100	40-75	20-40	7-25
	24-40	Silt loam, silty clay loam.	CL	A-6, A-7	0	100	100	90-100	75-95	25-50	10-35
	40-57	Loam, silt loam, sandy loam.	SC, CL	A-4, A-6, A-2	0-5	55-100	55-100	70-100	30-90	15-40	7-20
	57-60	Sandy loam, gravelly sandy loam, silt loam.	SM, ML	A-4, A-2	0-10	55-100	55-100	55-100	25-90	<20	NP-4
HmB---------------- Hochheim	0-7	Loam------------	ML, CL, CL-ML	A-4	0	100	85-100	85-100	60-90	20-30	3-10
	7-12	Clay loam, loam	CL, CH, SC	A-6, A-7	0-5	85-100	70-100	60-80	40-65	25-55	15-35
	12-60	Gravelly loam, gravelly sandy loam, gravelly fine sandy loam.	SM, SM-SC, ML, CL-ML	A-2, A-4, A-1	0-10	51-95	50-90	30-80	15-75	<20	NP-6
HoB, HoC2---------- Hortonville	0-14	Loamy fine sand	SM	A-2, A-4	0	95-100	95-100	60-100	15-40	---	NP
	14-31	Silty clay loam, clay loam, loam.	CL, CH	A-7, A-6	0-5	85-100	85-100	80-100	70-90	35-60	20-37
	31-60	Silty clay loam, clay loam, loam.	CL, SC	A-4, A-6	0-10	75-100	75-100	60-90	45-80	24-30	8-14
HrB, HrC2---------- Hortonville	0-8	Silt loam-------	ML, CL, CL-ML	A-4	0-5	95-100	95-100	85-100	60-90	20-30	3-10
	8-28	Silty clay loam, clay loam, loam.	CL, CH	A-7, A-6	0-5	85-100	85-100	80-100	70-90	35-60	20-37
	28-60	Silty clay loam, clay loam, loam.	CL, SC	A-4, A-6	0-10	75-100	75-100	60-90	45-80	24-30	8-14
Hu, Hw------------- Houghton	0-60	Sapric material	PT	A-8	0	---	---	---	---	---	---
KaB---------------- Kaukauna	0-9	Silty clay loam	CL	A-6, A-7	0	100	100	95-100	85-100	25-50	11-25
	9-37	Clay, silty clay	CH	A-7	0	100	100	95-100	85-100	55-80	30-50
	37-48	Silt loam, loam, very fine sandy loam.	CL, CL-ML, ML	A-4, A-6	0	100	100	85-100	55-85	20-30	3-15
	48-60	Stratified silt to very fine sand.	ML, CL-ML, SM, SM-SC	A-4	0	100	100	85-100	45-100	<20	NP-7

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Fragments > 3 inches	Percentage passing sieve number-- 4	10	40	200	Liquid limit	Plasticity index
	In				Pct					Pct	
Ke----------------- Keowns	0-8	Silt loam-------	ML, CL, CL-ML	A-4	0	100	100	85-100	60-90	20-30	3-10
	8-25	Silt loam, very fine sandy loam, sandy loam.	ML, CL, SM, SC	A-4, A-2	0	100	100	60-100	30-85	<20	NP-10
	25-60	Stratified silt loam to fine sand.	ML, SM	A-2, A-4	0	100	100	70-100	30-95	<20	NP-4
KmB---------------- Kewaunee	0-15	Loamy fine sand	SM	A-2	0	95-100	95-100	90-100	15-30	---	NP
	15-36	Clay, silty clay, silty clay loam.	CL, CH	A-7	0-5	90-100	90-100	90-100	75-95	45-70	30-45
	36-60	Clay, silty clay, silty clay loam.	CL, CH	A-6, A-7	0-5	90-100	90-100	90-100	65-95	30-60	15-35
KnB---------------- Kewaunee	0-10	Silt loam-------	ML, CL, CL-ML	A-4	0	95-100	95-100	85-100	50-90	20-30	3-10
	10-29	Clay, silty clay, silty clay loam.	CL, CH	A-7	0-5	90-100	90-100	85-100	70-95	45-70	30-45
	29-60	Clay, silty clay, silty clay loam.	CL, CH	A-6, A-7	0-5	90-100	90-100	85-100	65-95	30-60	15-35
KoC2--------------- Kewaunee	0-7	Silty clay loam	CL, CH	A-6, A-7	0	95-100	95-100	90-100	70-95	25-55	15-35
	7-27	Clay, silty clay, silty clay loam.	CL, CH	A-7	0-5	90-100	90-100	85-100	70-95	45-70	30-45
	27-60	Clay, silty clay, silty clay loam.	CL, CH	A-6, A-7	0-5	90-100	90-100	85-100	65-95	30-60	15-35
KpB, KpC2---------- Kidder	0-11	Loamy fine sand	SM	A-2	0	95-100	95-100	90-100	15-30	---	NP
	11-29	Clay loam, sandy clay loam, loam.	CL, SC	A-4, A-6	0-5	75-100	75-100	65-95	40-70	25-40	8-23
	29-60	Fine sandy loam, gravelly fine sandy loam, sandy loam.	SM	A-2, A-4	3-10	50-90	50-90	50-80	15-45	---	NP
KrB, KrC2---------- Kidder	0-9	Silt loam-------	ML, CL-ML, CL	A-4	0	95-100	95-100	85-100	60-90	20-30	3-10
	9-24	Clay loam, sandy clay loam, loam.	CL, SC	A-6, A-4	0-5	75-100	75-100	65-95	45-70	25-40	8-15
	24-60	Sandy loam, gravelly sandy loam, fine sandy loam.	SM, GM	A-2, A-4	3-10	50-90	50-90	50-80	15-45	---	NP
Ks----------------- Kingsville	0-7	Mucky loamy fine sand.	SM, ML, CL-ML, SM-SC	A-2, A-4	0	100	90-100	80-100	15-55	<25	NP-5
	7-60	Fine sand-------	SM, SW-SM, SP-SM	A-2, A-3	0	95-100	85-100	70-100	5-25	---	NP
KwB, KwC2---------- Knowles	0-6	Silt loam-------	ML, CL, CL-ML	A-4	0	100	100	90-100	85-95	20-30	3-10
	6-27	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	90-100	70-95	30-50	10-30
	27-32	Clay loam, sandy clay loam, loam.	CL, SC	A-4, A-6	0-5	75-100	75-100	60-95	40-70	20-40	8-25
	32-60	Unweathered bedrock.	---	---	---	---	---	---	---	---	---

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
KyA----------------- Korobago	0-9	Silt loam--------	ML, CL-ML	A-4	0	100	100	85-100	60-90	<25	NP-7
	9-19	Silt loam, loam, very fine sandy loam.	ML, CL-ML	A-4	0	100	100	85-100	50-90	<25	NP-7
	19-31	Stratified loamy very fine sand to loam.	SM, ML	A-2, A-4	0	95-100	95-100	75-95	30-75	<20	NP-4
	31-60	Silty clay loam, clay, clay loam.	CL, CH	A-6, A-7	0-5	85-100	85-100	80-100	65-100	35-75	15-50
LmA----------------- Lamartine	0-9	Silt loam--------	ML, CL, CL-ML	A-4	0	100	100	90-100	70-90	20-30	3-10
	9-25	Silt loam, silty clay loam.	CL, CH	A-6, A-7	0	100	100	90-100	70-95	35-60	15-40
	25-30	Clay loam, loam	CL, SC	A-6, A-7	0-5	75-100	75-100	65-95	45-80	25-50	11-30
	30-60	Gravelly sandy loam, gravelly loam, gravelly fine sandy loam.	SM, SM-SC, GM, GM-GC, ML	A-4, A-2	0-5	50-90	40-90	40-80	25-70	<30	NP-6
LrB, LrC2----------- LeRoy	0-10	Silt loam--------	ML, CL-ML, CL	A-4	0	100	100	90-100	70-90	20-30	3-10
	10-16	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	85-95	25-60	10-40
	16-19	Clay loam, loam, sandy clay loam.	CL, SC	A-6, A-7	0-2	75-100	75-95	65-90	45-65	25-50	11-30
	19-60	Gravelly loam, gravelly sandy loam, gravelly fine sandy loam.	SM, SM-SC, GM, GM-GC	A-2, A-4	3-10	50-85	45-80	40-65	25-40	<25	NP-6
LvB----------------- Lomira	0-9	Silt loam--------	ML, CL, CL-ML	A-4	0	100	100	90-100	70-90	20-30	3-10
	9-32	Silty clay loam, silt loam.	CL, CH	A-6, A-7	0	100	100	95-100	85-95	25-60	10-40
	32-37	Sandy clay loam, clay loam, loam.	CL, SC	A-6, A-7	0-2	85-100	80-95	70-90	45-65	20-50	11-30
	37-60	Gravelly loam, gravelly sandy loam, gravelly fine sandy loam.	SM, GM, GM-GC, SM-SC	A-2, A-4	3-10	50-85	45-80	40-65	25-40	<25	NP-6
LzB----------------- Lorenzo Variant	0-9	Loam-------------	ML	A-4	0-3	85-100	80-100	80-100	50-70	20-30	3-8
	9-14	Loam, clay loam, sandy clay loam.	CL	A-6, A-7	0-5	85-100	80-100	70-100	55-85	30-50	15-30
	14-19	Gravelly sandy loam, very gravelly sandy loam, gravelly loamy sand.	SM, GM	A-2	0-10	45-85	40-80	30-70	15-35	<20	NP-4
	19-32	Very gravelly loamy sand.	GP-GM	A-1	0-15	30-50	25-45	15-35	5-12	---	NP
	32-60	Clay loam, silty clay, clay.	CL	A-6, A-7	0-5	80-100	80-100	75-100	65-95	25-50	11-30
MaA----------------- Manawa	0-9	Silty clay loam	CL	A-6	0	100	100	95-100	85-95	25-40	11-20
	9-35	Silty clay, silty clay loam, clay.	CH, CL	A-7	0-5	90-100	90-100	85-100	65-95	45-70	30-45
	35-60	Silty clay, silty clay loam, clay.	CH, CL	A-6, A-7	0-5	90-100	90-100	85-100	65-95	30-60	15-35

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO	Frag- ments > 3 inches	Percentage passing sieve number--: 4	10	40	200	Liquid limit	Plas- ticity index
	In				Pct					Pct	
MhB, MhC2---------- McHenry	0-9	Silt loam-------	CL, ML, CL-ML	A-4, A-6	0	100	95-100	90-100	65-90	20-40	3-15
	9-21	Silty clay loam, clay loam, silt loam.	CL	A-7, A-6	0	100	95-100	90-100	70-95	35-50	20-35
	21-32	Sandy loam, sandy clay loam, clay loam.	SC, CL	A-6	0-5	90-100	85-95	65-95	35-85	25-40	11-20
	32-60	Fine sandy loam, sandy loam, gravelly sandy loam.	SM	A-2, A-4	2-10	75-95	70-90	60-80	25-45	<20	NP-4
Mn----------------- Menasha	0-7	Clay------------	CL, CH	A-6, A-7	0	100	100	95-100	90-100	25-70	15-50
	7-26	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	55-90	30-60
	26-60	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	55-90	30-60
MoA---------------- Morocco	0-7	Loamy fine sand	SM, SM-SC	A-2-4	0	100	100	50-100	15-35	<20	NP-5
	7-60	Fine sand, sand	SM, SP-SM	A-3, A-2-4	0	100	80-100	50-100	5-25	---	NP
MtA---------------- Mosel	0-14	Silt loam-------	ML, CL-ML, CL	A-4	0	95-100	95-100	85-100	60-90	20-30	3-10
	14-26	Loam, clay loam, sandy clay loam.	SC, CL	A-6	0	75-100	70-100	45-95	40-90	20-40	11-25
	26-60	Silty clay loam, silty clay, clay.	CL, CH	A-7, A-6	0-5	90-100	85-100	80-100	70-95	30-70	15-45
Na----------------- Navan	0-18	Silt loam-------	CL-ML, CL, ML	A-4, A-6	0	100	100	85-100	50-90	20-40	3-15
	18-38	Clay loam, loam, sandy clay loam.	SC, CL	A-6	0	75-100	70-100	45-95	40-80	25-40	11-25
	38-60	Silty clay, silty clay loam, clay.	CL, CH	A-7, A-6	0-5	90-100	85-100	80-100	70-100	30-70	15-45
NeA---------------- Nebago	0-34	Fine sand-------	SM, SP-SM	A-2, A-3	0	100	100	80-100	5-35	---	NP
	34-60	Silty clay, clay, silty clay loam.	CL, CH	A-7, A-6	0-5	85-100	85-100	85-100	70-100	30-80	15-50
Ng----------------- Nebago Variant	0-7	Mucky loamy fine sand.	SM	A-2	0	100	100	80-100	15-30	---	NP
	7-25	Fine sand-------	SP-SM	A-2, A-3	0	100	100	80-100	5-12	---	NP
	25-43	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	55-80	30-50
	43-60	Sand, fine sand	SP-SM	A-2, A-3	0	100	100	80-100	5-12	---	NP
NhA---------------- Neenah	0-7	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	90-100	25-70	15-50
	7-29	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	55-90	30-60
	29-60	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	55-90	30-60
NnA---------------- Nenno	0-11	Loam------------	ML, CL, CL-ML	A-4	0-1	95-100	95-100	75-85	50-70	20-30	3-10
	11-21	Clay loam, loam, silty clay loam.	CL, CH, SC	A-6, A-7	0-2	85-100	70-100	60-100	40-95	25-55	11-35
	21-60	Gravelly loam, gravelly sandy loam, gravelly fine sandy loam.	SM, SM-SC, ML, CL-ML	A-2, A-4, A-1	0-10	50-95	50-90	30-80	15-75	<20	NP-6

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
OaB, OaC: Oakville	0-4	Fine sand	SM, SP, SP-SM	A-2, A-3	0	100	100	50-100	0-35	---	NP
	4-60	Fine sand	SM, SP, SP-SM	A-2, A-3	0	100	95-100	65-100	0-25	---	NP
OmB: Omro	0-8	Clay loam	CL	A-6	0	95-100	95-100	85-100	65-90	25-40	10-20
	8-36	Clay, silty clay, silty clay loam.	CH, CL	A-7	0-3	85-100	85-100	85-100	65-95	45-70	30-45
	36-60	Loam, gravelly sandy loam, gravelly fine sandy loam.	SM, SM-SC, ML, CL-ML	A-4, A-2	0-10	50-95	50-90	30-85	15-75	<20	NP-7
Os: Ossian	0-12	Silt loam	ML, CL, CL-ML	A-4	0	100	100	100	70-100	20-30	3-10
	12-60	Silt loam, silty clay loam.	CL	A-6	0	100	100	100	70-100	25-40	10-20
Pa: Palms	0-25	Sapric material	PT	---	---	---	---	---	---	---	---
	25-60	Clay loam, fine sandy loam, silt loam.	CL-ML, CL, ML	A-4, A-6	0	85-100	80-100	70-100	50-90	12-40	2-20
Pg*, Ph*. Pits											
PsB: Plano	0-15	Silt loam	CL-ML, ML, CL	A-4, A-6	0	100	100	95-100	95-100	20-30	3-15
	15-47	Silty clay loam, silt loam.	CL	A-6, A-7	0	100	100	95-100	95-100	25-50	10-30
	47-60	Sandy loam, sandy clay loam	SM, CL, SC	A-2, A-4 A-6	0-5	75-100	70-95	60-90	25-60	<40	NP-20
Pt: Poy	0-9	Silty clay loam	CL, CH, MH	A-6, A-7	0	100	100	90-100	70-100	25-70	15-50
	9-34	Silty clay, clay, silty clay loam.	CH	A-7	0	100	100	90-100	70-100	55-90	30-60
	34-60	Sand, fine sand	SM, SP-SM	A-2, A-3	0	85-100	85-100	60-100	5-35	---	NP
Pu: Poygan	0-9	Silty clay loam	CL, CH	A-7	0	100	100	90-100	75-95	45-55	25-35
	9-33	Silty clay, silty clay loam, clay.	CL, CH	A-7	0-5	90-100	90-100	85-100	70-95	45-70	30-45
	33-60	Clay, silty clay, silty clay loam.	CL, CH	A-7, A-6	0-5	90-100	90-100	85-100	70-100	30-70	15-45
PzB: Puchyan	0-21	Loamy fine sand	SM	A-2, A-4	0	100	100	60-100	15-40	---	NP
	21-31	Loam, sandy loam, fine sandy loam.	SM, SC, ML, CL	A-2, A-4, A-6	0	100	100	60-100	30-70	10-35	2-20
	31-60	Silt loam	CL, CL-ML	A-4, A-6	0	100	100	90-100	70-90	20-40	5-20
RhB, RhC2, RhD2: Ritchey	0-8	Silt loam	ML, CL, CL-ML	A-4, A-6	0	95-100	95-100	90-100	70-95	20-35	1-15
	8-17	Clay loam, loam	CL	A-6	0-35	65-100	65-100	75-100	50-90	25-40	10-20
	17-60	Unweathered bedrock.	---	---	---	---	---	---	---	---	---
ScB: St. Charles	0-12	Silt loam	CL-ML, CL, ML	A-4, A-6	0	100	100	95-100	95-100	20-35	3-15
	12-46	Silty clay loam, silt loam.	CL	A-6	0	100	100	95-100	90-100	25-40	10-25
	46-60	Sandy loam, sandy clay loam, fine sandy loam.	SM, CL, SC	A-2, A-4 A-6	0-5	75-100	70-95	60-90	25-60	<40	NP-20

See footnote at end of table.

TABLE 14.--ENGINEERING PROPERTIES AND CLASSIFICATIONS--Continued

Soil name and map symbol	Depth	USDA texture	Classification		Frag- ments > 3 inches	Percentage passing sieve number--				Liquid limit	Plas- ticity index
			Unified	AASHTO		4	10	40	200		
	In				Pct					Pct	
TuB----------------- Tustin	0-26	Fine sand--------	SM, SP-SM	A-2, A-3	0	100	100	50-100	5-35	---	NP
	26-30	Sandy clay loam, loam, sandy loam.	SC, CL	A-6	0-5	90-100	90-100	80-90	45-55	20-30	7-13
	30-60	Silty clay, clay loam, clay.	CL, CH	A-7, A-6	0-5	90-100	90-100	85-100	65-100	30-80	15-50
UoA*. Udorthents											
We------------------ Wauseon	0-13	Silt loam--------	ML, CL-ML	A-4	0	100	95-100	90-100	50-90	20-35	3-8
	13-35	Fine sandy loam, loamy fine sand, silt loam	SM, SM-SC, ML, CL-ML	A-2, A-4	0	100	95-100	50-100	20-90	<30	NP-7
	35-60	Clay, silty clay, silty clay loam.	CH, CL, MH, ML	A-7, A-6	0-5	80-100	80-100	70-100	65-95	25-70	11-36
WfB----------------- Whalan	0-14	Loamy fine sand	SM	A-2	0	100	95-100	90-100	15-30	---	NP
	14-32	Clay loam, loam	CL	A-6, A-7	0-5	95-100	85-100	80-95	60-90	30-45	10-30
	32-60	Weathered bedrock.	---	---	---	---	---	---	---	---	---
WhB, WhC2----------- Whalan	0-9	Silt loam--------	ML	A-4	0	100	95-100	85-95	60-90	30-40	5-10
	9-35	Clay loam, loam	CL	A-6, A-7	0-5	95-100	85-100	80-95	60-90	30-45	10-25
	35-60	Weathered bedrock.	---	---	---	---	---	---	---	---	---
Wm------------------ Willette	0-26	Sapric material	PT	---	---	---	---	---	---	---	---
	26-60	Silty clay, silty clay loam, clay.	CL, CH	A-7	0	100	95-100	90-100	85-100	45-80	25-50
WnB----------------- Winneconne	0-7	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	90-100	25-70	15-50
	7-22	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	55-90	30-60
	22-60	Clay, silty clay	CH	A-7	0	100	100	95-100	90-100	55-90	30-60
YaA----------------- Yahara	0-24	Silt loam--------	ML, CL, CL-ML	A-4	0	100	100	85-100	65-95	20-30	3-10
	24-60	Stratified very fine sand to silt loam.	ML, SM	A-4	0	100	100	80-100	40-95	<20	NP-4
ZtA----------------- Zittau	0-9	Silty clay loam	CL, CH	A-6, A-7	0	100	100	95-100	90-100	25-70	15-50
	9-33	Silty clay, clay, silty clay loam.	CH	A-7	0	100	100	95-100	90-100	55-90	30-60
	33-60	Sand, fine sand, loamy sand.	SM, SP-SM	A-2, A-3	0	85-100	85-100	60-100	5-35	---	NP

* See map unit description for the composition and behavior of the map unit.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS

[The symbol < means less than; > means greater than. The erosion tolerance factor (T) is for the entire profile. Wind erodibility group is for the surface layer. Absence of an entry means data were not available or were not estimated]

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH				
Ak--------------- Adrian	0-22 22-60	2.0-6.0 6.0-20	0.35-0.45 0.03-0.08	5.6-7.8 6.1-8.4	--------------- Low-----------	--- ---	---	3
AtA-------------- Atterberry	0-13 13-42 42-60	0.6-2.0 0.2-2.0 0.6-2.0	0.22-0.24 0.18-0.20 0.20-0.22	5.6-7.3 5.1-6.0 5.6-7.3	Low----------- Moderate------ Low-----------	0.32 0.43 0.43	5	5
BoB-------------- Borth	0-8 8-30 30-60	0.2-0.6 <0.2 6.0-20	0.12-0.23 0.09-0.13 0.04-0.10	6.1-7.8 5.6-8.4 6.6-8.4	Moderate------ High---------- Low-----------	0.43 0.32 0.15	3	4
BrB-------------- Brems	0-8 8-60	6.0-20 6.0-20	0.07-0.09 0.05-0.08	5.1-7.3 4.5-6.0	Low----------- Low-----------	0.17 0.17	5	1
CeB, CeC2-------- Casco	0-7 7-15 15-60	0.6-2.0 0.6-2.0 >20	0.20-0.24 0.12-0.19 0.02-0.04	5.6-7.3 5.6-7.8 7.4-8.4	Low----------- Moderate------ Low-----------	0.32 0.32 0.10	3	5
Ed--------------- Edwards	0-23 23-60	2.0-6.0 ---	0.35-0.45 ---	5.6-7.8 7.4-8.4	--------------- ---------------	--- ---	---	3
ElD2------------- Eleva	0-5 5-10 10-21 21-60	0.6-2.0 0.6-6.0 2.0-20 ---	0.20-0.22 0.12-0.19 0.05-0.10 ---	5.1-7.3 5.1-6.5 5.1-6.5 ---	Low----------- Low----------- Low----------- ---------------	0.32 0.24 0.10 ---	3	5
FkA-------------- Fisk	0-24 24-27 27-39 39-60	6.0-20 0.6-2.0 0.6-2.0 0.6-2.0	0.09-0.14 0.12-0.19 0.17-0.22 0.14-0.22	5.1-7.3 6.1-7.8 6.1-7.8 6.6-8.4	Low----------- Low----------- Low----------- Low-----------	0.17 0.37 0.37 0.37	4	2
Fn*. Fluvaquents								
FsB, FsC2-------- Fox	0-11 11-19 19-31 31-60	0.6-2.0 0.6-2.0 0.6-2.0 >6.0	0.20-0.24 0.15-0.22 0.15-0.19 0.02-0.04	5.1-7.3 5.1-7.3 5.6-7.8 7.9-8.4	Low----------- Moderate------ Moderate------ Low-----------	0.32 0.32 0.32 0.10	4	5
GnB-------------- Grellton	0-13 13-24 24-40 40-57 57-60	0.6-2.0 0.6-2.0 0.6-2.0 0.6-2.0 0.6-2.0	0.13-0.18 0.12-0.19 0.18-0.22 0.15-0.22 0.10-0.22	5.6-7.3 5.1-6.5 5.1-7.3 5.6-7.3 5.6-8.4	Low----------- Moderate------ Moderate------ Moderate------ Low-----------	0.24 0.32 0.32 0.32 0.32	5	3
HmB-------------- Hochheim	0-7 7-12 12-60	0.6-2.0 0.6-2.0 0.2-2.0	0.20-0.24 0.15-0.19 0.08-0.17	6.1-7.8 6.1-7.8 7.4-8.4	Low----------- Moderate------ Low-----------	0.28 0.28 0.28	4	5
HoB, HoC2-------- Hortonville	0-14 14-31 31-60	2.0-6.0 0.2-2.0 0.2-2.0	0.11-0.13 0.15-0.20 0.14-0.20	5.1-7.3 5.1-7.8 7.4-8.4	Low----------- Moderate------ Moderate------	0.17 0.37 0.37	5	2
HrB, HrC2-------- Hortonville	0-8 8-28 28-60	0.6-2.0 0.2-2.0 0.2-2.0	0.20-0.24 0.15-0.20 0.14-0.20	5.1-7.3 5.1-7.8 7.4-8.4	Low----------- Moderate------ Moderate------	0.37 0.37 0.37	5	5
Hu, Hw----------- Houghton	0-60	2.0-6.0	0.35-0.45	5.6-7.8	---------------	---	---	3

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH				
KaB--------------	0-9	0.2-0.6	0.21-0.23	5.6-7.8	Low------------	0.37	4	4
Kaukauna	9-37	<0.2	0.09-0.13	5.6-8.4	High-----------	0.28		
	37-48	0.2-2.0	0.17-0.22	6.6-8.4	Low------------	0.28		
	48-60	0.2-2.0	0.17-0.22	7.4-8.4	Low------------	0.28		
Ke---------------	0-8	0.6-2.0	0.20-0.24	6.6-8.4	Low------------	0.28	5	5
Keowns	8-25	0.6-2.0	0.12-0.22	6.6-8.4	Low------------	0.28		
	25-60	0.6-2.0	0.11-0.22	7.4-8.4	Low------------	0.28		
KmB--------------	0-15	6.0-20	0.12-0.14	5.6-7.3	Low------------	0.17	3	2
Kewaunee	15-36	0.06-0.6	0.09-0.20	5.6-7.8	Moderate-------	0.37		
	36-60	0.06-0.6	0.08-0.20	7.4-8.4	Moderate-------	0.37		
KnB--------------	0-10	0.6-2.0	0.20-0.24	5.6-7.3	Low------------	0.37	3	5
Kewaunee	10-29	0.06-0.6	0.09-0.20	5.6-7.8	Moderate-------	0.37		
	29-60	0.06-0.6	0.08-0.20	7.4-8.4	Moderate-------	0.37		
KoC2-------------	0-7	0.2-0.6	0.11-0.23	5.6-7.3	Moderate-------	0.37	2	4
Kewaunee	7-27	0.06-0.6	0.09-0.20	5.6-7.8	Moderate-------	0.37		
	27-60	0.06-0.6	0.08-0.20	7.4-8.4	Moderate-------	0.37		
KpB, KpC2--------	0-11	6.0-20	0.11-0.14	6.1-7.8	Low------------	0.17	5	2
Kidder	11-29	0.6-2.0	0.15-0.19	5.6-7.8	Moderate-------	0.32		
	29-60	2.0-6.0	0.09-0.11	7.4-8.4	Low------------	0.32		
KrB, KrC2--------	0-9	0.6-2.0	0.20-0.24	6.1-7.8	Low------------	0.32	5	5
Kidder	9-24	0.6-2.0	0.15-0.19	5.6-7.8	Moderate-------	0.32		
	24-60	2.0-6.0	0.09-0.11	7.4-8.4	Low------------	0.32		
Ks---------------	0-7	2.0-20	0.07-0.15	4.5-6.0	Low------------	0.24	5	2
Kingsville	7-60	6.0-20	0.07-0.10	4.5-6.5	Low------------	0.17		
KwB, KwC2--------	0-6	0.6-2.0	0.22-0.24	5.6-7.3	Low------------	0.32	4	5
Knowles	6-27	0.6-2.0	0.18-0.22	5.1-6.5	Moderate-------	0.43		
	27-32	0.6-2.0	0.15-0.19	6.1-8.4	Moderate-------	0.43		
	32-60	---	---	---	---------------	---		
KyA--------------	0-9	0.6-2.0	0.20-0.24	6.1-7.8	Low------------	0.28	4	5
Korobago	9-19	0.6-2.0	0.17-0.22	6.1-7.8	Low------------	0.28		
	19-31	0.6-6.0	0.13-0.17	6.1-7.8	Low------------	0.28		
	31-60	0.06-0.6	0.08-0.20	7.4-8.4	Moderate-------	0.37		
LmA--------------	0-9	0.6-2.0	0.22-0.24	5.6-7.8	Low------------	0.32	5	5
Lamartine	9-25	0.6-2.0	0.18-0.22	5.6-7.8	Moderate-------	0.43		
	25-30	0.6-2.0	0.15-0.19	5.6-7.8	Moderate-------	0.43		
	30-60	0.6-6.0	0.17-0.19	7.9-8.4	Low------------	0.32		
LrB, LrC2--------	0-10	0.6-2.0	0.22-0.24	5.6-7.3	Low------------	0.37	4	5
LeRoy	10-16	0.6-2.0	0.18-0.20	5.1-7.3	Moderate-------	0.37		
	16-19	0.6-2.0	0.13-0.19	6.6-8.4	Moderate-------	0.37		
	19-60	0.6-2.0	0.08-0.15	7.9-8.4	Low------------	0.28		
LvB--------------	0-9	0.6-2.0	0.22-0.24	5.6-7.3	Low------------	0.37	4	5
Lomira	9-32	0.6-2.0	0.18-0.20	4.5-7.3	Moderate-------	0.37		
	32-37	0.6-2.0	0.13-0.19	6.6-8.4	Moderate-------	0.37		
	37-60	0.6-2.0	0.08-0.15	7.9-8.4	Low------------	0.28		
LzB--------------	0-9	0.6-2.0	0.20-0.22	6.1-7.8	Low------------	0.28	3	5
Lorenzo Variant	9-14	0.6-2.0	0.15-0.19	6.1-7.8	Moderate-------	0.28		
	14-19	2.0-6.0	0.06-0.10	6.6-8.4	Low------------	0.28		
	19-32	>6.0	0.03-0.06	7.4-8.4	Low------------	0.10		
	32-60	0.06-0.6	0.10-0.16	7.4-8.4	Moderate-------	0.37		
MaA--------------	0-9	0.2-0.6	0.21-0.23	6.1-7.8	Moderate-------	0.37	2	7
Manawa	9-35	0.06-0.2	0.09-0.20	6.1-8.4	Moderate-------	0.37		
	35-60	0.06-0.2	0.08-0.20	7.4-8.4	Moderate-------	0.37		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors K	Erosion factors T	Wind erodibility group
	In	In/hr	In/in	pH				
MhB, MhC2 McHenry	0-9	0.6-2.0	0.22-0.24	5.1-7.3	Low	0.37	5	5
	9-21	0.6-2.0	0.15-0.22	5.1-7.3	Moderate	0.37		
	21-32	0.6-2.0	0.12-0.19	5.1-7.8	Moderate	0.37		
	32-60	2.0-6.0	0.08-0.16	7.4-8.4	Low	0.28		
Mn Menasha	0-7	0.2-0.6	0.12-0.23	6.1-7.8	Moderate	0.32	3	4
	7-26	<0.2	0.09-0.13	6.1-8.4	High	0.32		
	26-60	<0.2	0.08-0.12	7.4-8.4	High	0.32		
MoA Morocco	0-7	6.0-20	0.10-0.12	5.1-6.5	Low	0.17	5	2
	7-60	6.0-20	0.05-0.07	4.5-6.0	Low	0.17		
MtA Mosel	0-14	0.6-2.0	0.20-0.24	5.6-7.8	Low	0.28	5	5
	14-26	0.6-2.0	0.15-0.19	5.6-7.8	Low	0.28		
	26-60	0.06-0.6	0.08-0.20	7.4-8.4	Moderate	0.28		
Na Navan	0-18	0.6-2.0	0.20-0.24	6.1-8.4	Low	0.28	5	5
	18-38	0.6-2.0	0.15-0.19	6.6-8.4	Low	0.28		
	38-60	0.06-0.6	0.10-0.20	7.4-8.4	Moderate	0.28		
NeA Nebago	0-34	6.0-20	0.07-0.10	5.6-7.3	Low	0.17	4	1
	34-60	0.06-0.6	0.09-0.20	6.1-8.4	High	0.32		
Ng Nebago Variant	0-7	6.0-20	0.12-0.16	5.1-6.5	Low	0.17	4	2
	7-25	6.0-20	0.06-0.10	5.1-6.5	Low	0.17		
	25-43	0.06-0.2	0.08-0.13	6.1-7.8	High	0.37		
	43-60	6.0-20	0.04-0.07	6.6-7.8	Low	0.10		
NhA Neenah	0-7	0.2-0.6	0.12-0.23	6.1-7.8	Moderate	0.32	3	4
	7-29	<0.2	0.09-0.13	5.6-8.4	High	0.32		
	29-60	<0.2	0.08-0.12	7.4-8.4	High	0.32		
NnA Nenno	0-11	0.6-2.0	0.20-0.24	6.6-7.8	Low	0.32	4	5
	11-21	0.6-2.0	0.15-0.20	6.6-7.8	Moderate	0.32		
	21-60	0.6-2.0	0.08-0.17	7.4-8.4	Low	0.24		
OaB, OaC Oakville	0-4	6.0-20	0.07-0.09	5.6-7.3	Low	0.15	5	1
	4-60	6.0-20	0.06-0.08	4.5-7.3	Low	0.15		
OmB Omro	0-8	0.2-0.6	0.17-0.19	5.6-7.8	Moderate	0.32	2	6
	8-36	0.06-0.6	0.09-0.13	5.6-7.8	Moderate	0.32		
	36-60	0.6-2.0	0.08-0.19	7.4-8.4	Low	0.32		
Os Ossian	0-12	0.6-2.0	0.22-0.24	6.6-7.8	Moderate	0.28	5	5
	12-60	0.6-2.0	0.20-0.22	6.6-7.8	Moderate	0.28		
Pa Palms	0-25	0.2-6.0	0.35-0.45	5.5-7.8	---------------	0.10	5	3
	25-60	0.2-2.0	0.14-0.22	6.1-8.4	Low	0.10		
Pg*, Ph*. Pits								
PsB Plano	0-15	0.6-2.0	0.22-0.24	5.6-7.3	Low	0.32	5	5
	15-47	0.6-2.0	0.18-0.20	5.6-7.3	Moderate	0.43		
	47-60	0.6-2.0	0.11-0.22	6.1-8.4	Low	0.43		
Pt Poy	0-9	0.2-0.6	0.11-0.23	6.1-7.3	High	0.28	3	4
	9-34	<0.2	0.09-0.13	6.1-8.4	High	0.28		
	34-60	6.0-20	0.04-0.07	6.6-8.4	Low	0.15		
Pu Poygan	0-9	0.2-0.6	0.11-0.23	6.1-7.8	Moderate	0.37	3	7
	9-33	0.06-0.2	0.09-0.18	6.1-7.8	Moderate	0.37		
	33-60	0.06-0.2	0.08-0.20	7.4-8.4	Moderate	0.37		
PzB Puchyan	0-21	2.0-20	0.11-0.14	5.1-6.5	Low	0.17	5	2
	21-31	0.6-6.0	0.12-0.19	5.6-6.5	Low	0.28		
	31-60	0.6-2.0	0.20-0.22	6.1-7.3	Low	0.28		

See footnote at end of table.

TABLE 15.--PHYSICAL AND CHEMICAL PROPERTIES OF SOILS--Continued

Soil name and map symbol	Depth	Permeability	Available water capacity	Soil reaction	Shrink-swell potential	Erosion factors		Wind erodibility group
						K	T	
	In	In/hr	In/in	pH				
RhB, RhC2, RhD2--	0-8	0.6-2.0	0.22-0.24	5.6-7.8	Low-----------	0.37	2	5
Ritchey	8-17	0.6-2.0	0.18-0.20	6.1-8.4	Moderate------	0.37		
	17-60	---	---	---	--------------	---		
ScB--------------	0-12	0.6-2.0	0.22-0.24	5.1-7.3	Low-----------	0.37	5	5
St. Charles	12-46	0.6-2.0	0.18-0.20	5.1-7.3	Moderate------	0.37		
	46-60	0.6-2.0	0.11-0.22	6.1-8.4	Low-----------	0.37		
TuB--------------	0-26	6.0-20	0.07-0.09	5.1-7.3	Low-----------	0.17	5	1
Tustin	26-30	0.6-2.0	0.16-0.18	5.6-7.3	Low-----------	0.32		
	30-60	0.06-0.2	0.10-0.16	5.6-8.4	Moderate------	0.32		
UoA*. Udorthents								
We---------------	0-13	0.6-2.0	0.20-0.22	6.1-7.3	Low-----------	0.28	5	5
Wauseon	13-35	0.6-2.0	0.06-0.16	6.6-7.8	Low-----------	0.17		
	35-60	<0.6	0.08-0.18	7.4-7.8	Moderate------	0.32		
WfB--------------	0-14	6.0-20	0.22-0.24	5.6-7.3	Low-----------	0.32	4	2
Whalan	14-32	0.6-2.0	0.17-0.19	5.1-6.5	Moderate------	0.32		
	32-60	---	---	---	--------------	---		
WhB, WhC2--------	0-9	0.6-2.0	0.22-0.24	5.6-7.3	Low-----------	0.32	4	5
Whalan	9-35	0.6-2.0	0.17-0.19	5.1-6.5	Moderate------	0.32		
	35-60	---	---	---	--------------	---		
Wm---------------	0-26	2.0-6.0	0.35-0.45	4.5-7.8	--------------	---	---	3
Willette	26-60	0.06-0.2	0.12-0.16	5.1-8.4	High----------	---		
WnB--------------	0-7	0.2-0.6	0.12-0.23	5.6-7.8	Moderate------	0.43	3	4
Winneconne	7-22	<0.2	0.09-0.13	5.6-7.8	High----------	0.32		
	22-60	<0.2	0.08-0.10	7.4-8.4	High----------	0.32		
YaA--------------	0-24	0.6-2.0	0.20-0.24	6.1-7.8	Low-----------	0.32	5	5
Yahara	24-60	0.6-2.0	0.14-0.16	7.4-8.4	Low-----------	0.43		
ZtA--------------	0-9	0.2-0.6	0.12-0.23	5.6-7.3	Moderate------	0.32	3	4
Zittau	9-33	<0.2	0.09-0.13	5.6-8.4	High----------	0.32		
	33-60	6.0-20	0.04-0.10	6.6-8.4	Low-----------	0.15		

* See map unit description for the composition and behavior of the map unit.

TABLE 16.--SOIL AND WATER FEATURES

[Absence of an entry indicates the feature is not a concern. The symbol > means greater than]

Soil name and map symbol	Hydrologic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
Ak----------------- Adrian	A/D	Frequent----	Long------	Nov-May	0-1.0	Apparent	Nov-May	>60	---	High-----	High-----	Moderate.
AtA---------------- Atterberry	B	Occasional	Very brief	Nov-May	1.0-3.0	Apparent	Mar-Jun	>60	---	High-----	High-----	Moderate.
BoB---------------- Borth	C	None--------	---	---	3.0-6.0	Apparent	Nov-May	>60	---	Moderate	High-----	Low.
BrB---------------- Brems	A	None--------	---	---	2.5-3.5	Apparent	Jan-Apr	>60	---	Low------	Low------	High.
CeB, CeC2---------- Casco	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Low.
Ed----------------- Edwards	A/D	Frequent----	Long------	Sep-May	0-1.0	Apparent	Sep-Jun	>60	---	High-----	High-----	Low.
ElD2--------------- Eleva	B	None--------	---	---	>6.0	---	---	20-40	Rippable	Moderate	Low------	Moderate.
FkA---------------- Fisk	B	None--------	---	---	1.0-3.0	Apparent	Nov-Jun	>60	---	High-----	High-----	Moderate.
Fn*. Fluvaquents												
FsB, FsC2---------- Fox	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Low------	Moderate.
GnB---------------- Grellton	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
HmB---------------- Hochheim	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
HoB, HoC2, HrB, HrC2------------- Hortonville	B	None--------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
Hu, Hw------------- Houghton	A/D	Frequent----	Long------	Nov-May	0-1.0	Apparent	Sep-Jun	>60	---	High-----	High-----	Low.
KaB---------------- Kaukauna	C	None--------	---	---	3.0-6.0	Apparent	Nov-May	>60	---	Moderate	High-----	Low.
Ke----------------- Keowns	B/D	Frequent----	Brief-----	Mar-Apr	0-1.0	Apparent	Oct-May	>60	---	High-----	High-----	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
KmB, KnB---------- Kewaunee	C	None---------	---	---	>3.0	---	---	>60	---	Moderate	High-----	Low.
KoC2-------------- Kewaunee	C	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Low.
KpB, KpC2, KrB, KrC2------------- Kidder	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Low.
Ks---------------- Kingsville	A/D	Frequent----	Brief-----	Mar-May	0-1.0	Apparent	Jan-Apr	>60	---	Moderate	High-----	High.
KwB, KwC2--------- Knowles	B	None---------	---	---	>6.0	---	---	20-40	Hard	High-----	Moderate	Moderate.
KyA--------------- Korobago	C	Occasional	Brief-----	Mar-May	1.0-3.0	Perched	Nov-Jun	>60	---	High-----	High-----	Low.
LmA--------------- Lamartine	C	Occasional	Very brief	Nov-May	1.0-3.0	Apparent	Nov-May	>60	---	High-----	High-----	Low.
LrB, LrC2--------- LeRoy	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	Moderate	Moderate.
LvB--------------- Lomira	B	None---------	---	---	>6.0	---	---	>60	---	High-----	Moderate	Moderate.
LzB--------------- Lorenzo Variant	C	None---------	---	---	2.0-3.5	Perched	Mar-May	>60	---	Moderate	High-----	Low.
MaA--------------- Manawa	C	Occasional	Brief-----	Nov-May	1.0-3.0	Perched	Nov-Jun	>60	---	High-----	High-----	Low.
MhB, MhC2--------- McHenry	B	None---------	---	---	>6.0	---	---	>60	---	Moderate	High-----	Moderate.
Mn---------------- Menasha	D	Frequent----	Long------	Apr-May	0-1.0	Perched	Nov-May	>60	---	High-----	High-----	Low.
MoA--------------- Morocco	B	None---------	---	---	1.0-3.0	Apparent	Jan-Apr	>60	---	Moderate	Low------	High.
MtA--------------- Mosel	C	Occasional	Brief-----	Mar-Apr	1.0-3.0	Perched	Nov-May	>60	---	High-----	High-----	Low.
Na---------------- Navan	D	Frequent----	Long------	Nov-May	0-1.0	Perched	Nov-May	>60	---	High-----	High-----	Low.
NeA--------------- Nebago	C	None---------	---	---	1.0-3.0	Perched	Nov-May	>60	---	Moderate	High-----	Low.
Ng---------------- Nebago Variant	A/D	Frequent----	Brief-----	Mar-May	0-1.0	Perched	Nov-May	>60	---	Moderate	Moderate	Moderate.
NhA--------------- Neenah	C	Occasional	Long------	Apr-May	1.0-3.0	Perched	Nov-May	>60	---	High-----	High-----	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
NnA: Nenno	B	Occasional	Brief	Nov-May	1.0-3.0	Apparent	Nov-May	>60	---	High	High	Low.
OaB, OaC: Oakville	A	None	---	---	>6.0	---	---	>60	---	Low	Low	Moderate.
OmB: Omro	C	None	---	---	>6.0	---	---	>60	---	Moderate	High	Low.
Os: Ossian	B/D	Frequent	Brief	Feb-Nov	0-1.0	Apparent	Nov-Jul	>60	---	High	High	Low.
Pa: Palms	A/D	Frequent	Long	Nov-May	0-1.0	Apparent	Nov-May	>60	---	High	High	Moderate.
Pg*, Ph*. Pits												
PsB: Plano	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Low.
Pt: Poy	D	Frequent	Long	Apr-May	0-1.0	Perched	Nov-May	>60	---	High	High	Low.
Pu: Poygan	D	Frequent	Long	Nov-Jun	0-1.0	Perched	Nov-Jul	>60	---	High	High	Low.
PzB: Puchyan	A	None	---	---	3.0-6.0	Apparent	Apr-Jun	>60	---	Moderate	Low	Moderate.
RhB, RhC2, RhD2: Ritchey	D	None	---	---	>6.0	---	---	10-20	Hard	Moderate	Moderate	Low.
ScB: St. Charles	B	None	---	---	>6.0	---	---	>60	---	High	Moderate	Moderate.
TuB: Tustin	B	None	---	---	>6.0	---	---	>60	---	Moderate	High	Low.
UoA*. Udorthents												
We: Wauseon	B/D	Frequent	Long	Nov-May	0-1.0	Perched	Jan-Apr	>60	---	High	High	Low.
WfB, WhB, WhC2: Whalan	B	None	---	---	>6.0	---	---	20-40	Hard	Moderate	Moderate	Low.
Wm: Willette	A/D	Frequent	Long	Nov-May	0-1.0	Perched	Nov-May	>60	---	High	High	Low.
WnB: Winneconne	C	None	---	---	3.0-5.0	Perched	Nov-May	>60	---	Moderate	High	Low.

See footnote at end of table.

TABLE 16.--SOIL AND WATER FEATURES--Continued

Soil name and map symbol	Hydro-logic group	Flooding			High water table			Bedrock		Potential frost action	Risk of corrosion	
		Frequency	Duration	Months	Depth	Kind	Months	Depth	Hardness		Uncoated steel	Concrete
					Ft			In				
YaA---------------- Yahara	C	Occasional	Brief-----	Mar-Apr	1.0-3.0	Apparent	Nov-May	>60	---	High-----	Moderate	Low.
ZtA---------------- Zittau	C	Occasional	Long------	Apr-May	1.0-3.0	Apparent	Nov-May	>60	---	High-----	High-----	Low.

* See map unit description for the composition and behavior of the map unit.

TABLE 17.--ENGINEERING TEST DATA

[Tests were made in cooperation with the Federal Highway Administration, Department of Transportation. Absence of an entry indicates that no determination was made]

Soil name and location	Parent material	Sample number	Depth	Moisture density: Maximum dry density	Moisture density: Optimum moisture	Percentage passing sieve--[1] No. 4	No. 10	No. 40	No. 200	Percentage smaller than--[1] 0.05 mm	0.02 mm	0.005 mm	0.002 mm	Liquid limit	Plasticity index	Classification: AASHTO	Classification: Unified
			In	Lb/cu ft	Pct									Pct			
Borth silty clay loam: Township of Winchester, NW1/4NW1/4NW1/4 sec. 31, T. 20 N., R. 15 E. (Modal)	Clayey water-laid sediments over sandy material.	s74w1-71-101-1	8-15	--	--	--	--	100	98	98	98	92	81	75	48	A-7-6	CH
		s74w1-71-101-2	30-60	106	15	--	--	100	11	6	4	3	3	--	NP[2]	A-2-4	SP-SM
Brems fine sand: Township of Wolf River NE1/4NW1/4 SE1/4 sec. 7, T. 20 N., R. 14 E. (Substratum has more sand larger than 0.08mm than modal)	Sandy material.	s75w1-71-76-1	8-25	--	--	--	100	95	10	10	8	5	4	--	NP[2]	A-3	SP-SM
		s75w1-71-76-2	41-60	104	14	--	100	98	3	2	1	1	1	--	NP[2]	A-3	SP
Fox silt loam: Township of Nepeuskun SE1/4NE1/4SE1/4 sec. 29, T. 17 N., R. 14 E. (Modal)	Loess over loamy outwash over sand and gravel outwash.	s73w1-71-4-1	19-23	--	--	95	93	84	58	55	44	29	23	40	22	A-6	CL
		s-73w1-71-4-2	31-60	--	--	86	79	62	17	13	7	3	2	--	NP[2]	A-2-4	SM
Hochheim loam: Township of Black Wolf, SW1/4NW1/4NW1/4 sec. 18, T. 17 N., R. 17 E. (Subsoil has less clay and more coarse fragments than modal)	Loamy glacial till.	s75w1-71-36-1	7-12	--	--	87	84	73	50	46	37	25	18	34	15	A-6	SC or CL
		s75w1-71-36-2	20-60	140	5	76	70	57	33	28	17	7	4	--	NP[2]	A-6	SC or CL

See footnotes at end of table.

TABLE 17.--ENGINEERING TEST DATA--Continued

Soil name and location	Parent material	Sample number	Depth	Moisture density: Maximum dry density	Moisture density: Optimum moisture	Percentage passing sieve--[1]: No. 4	No. 10	No. 40	No. 200	Percentage smaller than--[1]: 0.05 mm	0.02 mm	0.005 mm	0.002 mm	Liquid limit	Plasticity index	Classification: AASHTO	Unified
			In	Lb/cu ft	Pct									Pct			
Hortonville silt loam: Township of Neenah, NE1/4SW1/4SW1/4 sec. 9, T. 19 N., R. 17 E. (Subsoil lacks interfingering and has more clay than modal)	Loamy glacial till.	s73w1-71-59-1	12-20	--	--	--	100	98	86	84	77	61	50	59	37	A-7-6	CH
		s73w1-71-59-2	26-60	--	--	78	72	62	45	40	31	19	13	27	12	A-6	SC
Kewaunee silt loam: Township of Poygan, NW1/4NW1/4SW1/4 sec. 36, T. 19 N., R. 14 E. (Modal)	Clayey glacial till.	s73w1-71-57-1	13-18	--	--	--	100	96	81	78	71	56	44	57	37	A-7-6	CH
		s74w1-71-57-2	29-60	--	--	94	94	91	80	77	69	52	35	47	27	A-7-6	CL
Korobago silt loam: Township of Oshkosh, NE1/4NW1/4NE1/4 sec. 36, T. 19 N., R. 16 E. (Modal)	Silty and loamy water-laid sediments over glacial till.	s74w1-71-98-1	9-19	--	--	--	100	99	87	67	24	18	15	--	NP[2]	A-4	ML
		s74w1-71-98-2	36-60	--	--	--	100	99	93	89	77	54	36	40	22	A-6	CL
Korobago silt loam: Township of Oshkosh, SW1/4SE1/4SW1/4 sec. 29, T. 19 N., R. 16 E. (Substratum has less clay than modal)	Silty and loamy water-laid sediments over clayey glacial till.	s74w1-71-86-1	11-21	--	--	--	100	99	85	68	29	20	17	--	NP[2]	A-6	ML
		s74w1-71-86-2	32-60	120	12	95	91	85	70	65	53	34	22	26	11	A-6	CL
LeRoy silt loam: Township of Utica, NE1/4SE1/4NW1/4 sec. 29. T. 17 N., R. 15 E. (Substratum has more coarse fragments than modal)	Loess over loamy glacial till.	s75w1-71-20-1	16-19	--	--	--	100	98	86	80	67	47	38	49	29	A-7-6	CL
		s75w1-71-20-2	19-60	135	7	52	47	40	30	27	15	6	4	--	NP[2]	A-2-4	SM

See footnotes at end of table.

TABLE 17.--ENGINEERING TEST DATA--Continued

Soil name and location	Parent material	Sample number	Depth	Moisture density: Maximum dry density	Moisture density: Optimum moisture	Percentage passing sieve--[1] No. 4	No. 10	No. 40	No. 200	Percentage smaller than--[1] 0.05 mm	0.02 mm	0.005 mm	0.002 mm	Liquid limit	Plasticity index	Classification: AASHTO	Classification: Unified
			In	Lb/cu ft	Pct									Pct			
Lomira silt loam: Township of Utica, NE1/4SE1/4NW1/4 sec. 29, T. 17 N., R. 15 E. (Modal)	Loess over loamy glacial till.	s73w1-71-21-1	20-32	--	--	--	--	100	94	90	67	40	34	57	37	A-7-6	CH
Lorenzo Variant loam: Township of Algoma, SW1/4NW1/4SE1/4 sec. 34, T. 13 N., R. 16 E. (Modal)	Loamy outwash over sand and gravel outwash over glacial till.	s74w1-71-82-1	9-14	--	--	--	100	96	81	78	64	44	35	46	25	A-7-6	CL
		s74w1-71-82-2	19-32	--	--	42	37	30	11	8	4	2	2	--	NP[2]	A-1-3	GP-GM
		s74w1-71-82-3	32-60	--	--	87	83	77	68	64	55	39	27	41	24	A-7-6	CL
Manawa silty clay loam: Township of Black Wolf, NW1/4NW1/4SW1/4 sec. 31, T. 17 N., R. 17 E. (Substratum has more sand and less clay than modal)	Clayey glacial till.	s59w1-70-1-1	7-15	--	--	--	100	99	90	89	78	57	47	56	32	A-7-6	CH
		s59w1-79-1-2	48-57	--	--	81	81	75	64	61	54	39	27	33	17	A-6	CL
Menasha clay: Township of Rushford, SE1/4SE1/4NE1/4 sec. 6, T. 17 N., R. 15 E. (Substratum has more sand, more coarse fragments, and less clay than modal)	Clayey water-laid sediments.	s60w1-70-2-1	18-23	--	--	--	100	99	97	97	95	84	68	70	46	A-7-6	CH
		s60w1-70-2-2	30-37	--	--	93	91	89	81	81	78	69	54	55	32	A-7-6	CH
Neenah silty clay loam: Township of Neenah, SW1/4SW1/4SW1/4 sec. 7, T. 19 N., R. 17 E. (Modal)	Clayey water-laid sediments.	s74w1-71-92-1	7-11	--	--	--	--	--	--	100	99	98	84	77	50	A-7-6	CH
		s74w1-71-92-2	29-60	93	24	--	--	100	99	99	98	92	73	68	45	A-7-6	CH

See footnotes at end of table.

TABLE 17.--ENGINEERING TEST DATA--Continued

Soil name and location	Parent material	Sample number	Depth	Moisture density: Maximum dry density	Moisture density: Optimum moisture	Percentage passing sieve--[1] No. 4	No. 10	No. 40	No. 200	Percentage smaller than--[1] 0.05 mm	0.02 mm	0.005 mm	0.002 mm	Liquid limit	Plasticity index	Classification: AASHTO	Classification: Unified
			In	Lb/cu ft	Pct									Pct			
Omro clay loam: Township of Black Wolf, SW1/4NW1/4 NW1/4 sec. 18, T. 17 N., R. 17 E. (Modal)	Clayey glacial till over loamy glacial till.	s74w1-71-85-1	13-20	--	--	--	100	99	94	93	90	79	63	65	39	A-7-6	CH
		s74w1-71-85-2	36-60	--	--	73	67	56	28	22	11	4	2	--	NP[2]	A-2-4	SM
Ossian silt loam: Township of Utica, SW1/4NW1/4NW1/4 sec. 18, T. 17 N., R. 17 E. (Subsoil has more clay than modal)	Loess.	s73w1-71-38-1	13-20		--	--	--	100	90	86	67	40	33	54	36	A-7-6	CH
		s73w1-71-38-2	39-60	--	--	--	--	100	96	92	57	23	17	33	12	A-6	CL
Tustin fine sand: Township of Wolf River, SW1/4SE1/4NW1/4 sec. 11, T. 20 N., R. 14 E. (Shallower to mottling than modal)	Sandy material over clayey water-laid sediments.	s74w1-71-94-1	9-23	--	--	--	100	99	8	6	5	3	2	--	NP[2]	A-3	SP-SM
		s74w1-71 94-2	33-36	--	--	--	--	100	97	97	96	83	58	61	37	A-7-6	CH
Whalan silt loam: Township of Nepeuskun, NW1/4NW1/4NE1/4 sec. 2, T. 17 N., R. 14 E. (Modal)	Loamy glacial till over limestone bedrock.	s-73w1-71-22-1	18-23	--	--	--	100	95	64	63	54	39	34	43	26	A-7-6	CL
Winneconne silty clay loam: Township of Menasha, SE1/4NE1/4SW1/4 sec. 9, T. 20 N., R. 17 E. (Modal)	Clayey water-laid sediments.	s60w1-70-1-1	7-14	--	--	--	--	100	99	99	98	90	65	65	44	A-7-6	CH
		s60w1-70-1-2	21-27	--	--	--	--	--	--	100	99	91	70	60	40	A-7-6	CH

See footnotes at end of table.

TABLE 17.--ENGINEERING TEST DATA--Continued

Soil name and location	Parent material	Sample number	Depth	Moisture density: Maximum dry density	Moisture density: Optimum moisture	Percentage passing sieve--[1]: No. 4	No. 10	No. 40	No. 200	Percentage smaller than--[1]: 0.05 mm	0.02 mm	0.005 mm	0.002 mm	Liquid limit	Plasticity index	Classification: AASHTO	Unified
			In	Lb/cu ft	Pct									Pct			
Winneconne silty clay loam: Township of Neenah, SW1/4NW1/4SW1/4 sec. 33, T. 20 N., R. 17 E. (Modal)	Clayey water-laid sediments.	s59w1-70-2-1	8-19	100	20	--	100	99	98	98	97	86	64	69	38	A-7-5	CH
		s59w1-70-2-2	35-62	102	24	--	--	--	--	100	99	95	81	58	35	A-7-6	CH

[1]Results of this procedure may differ somewhat from the results obtained by the soil survey procedure of the Soil Conservation Service (SCS). In the AASHTO procedure, the fine material is analyzed by hydrometer method, and the various grain-size fractions are calculated on the basis of all material up to and including that 3 inches in diameter. In the SCS soil survey procedure, the fine material is analyzed by the pipette method, and the material coarser than 2 millimeters in diameter is excluded from the calculation of grain-size fraction. The mechanical analysis data used in this table are not suitable for use in naming textural classes of soil.

[2]NP means nonplastic.

TABLE 18.--CLASSIFICATION OF THE SOILS

[An asterisk in the first column indicates a taxadjunct to the series. See text for a description of those characteristics of this taxadjunct that are outside the range of the series]

Soil name	Family or higher taxonomic class
Adrian	Sandy or sandy-skeletal, mixed, euic, mesic Terric Medisaprists
Atterberry	Fine-silty, mixed, mesic Udollic Ochraqualfs
Borth	Clayey over sandy or sandy-skeletal, mixed, mesic Mollic Hapludalfs
*Brems	Mixed, mesic Aquic Udipsamments
Casco	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludalfs
Edwards	Marly, euic, mesic Limnic Medisaprists
Eleva	Coarse-loamy, mixed, mesic Typic Hapludalfs
Fisk	Sandy over loamy, mixed, mesic Aquic Dystric Eutrochrepts
Fluvaquents	Loamy, mixed, nonacid, mesic Fluvaquents
Fox	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Hapludalfs
Grellton	Fine-loamy, mixed, mesic Typic Hapludalfs
Hochheim	Fine-loamy, mixed, mesic Typic Argiudolls
*Hortonville	Fine-loamy, mixed, mesic Glossoboric Hapludalfs
Houghton	Euic, mesic Typic Medisaprists
Kaukauna	Clayey over loamy, mixed, mesic Mollic Hapludalfs
Keowns	Coarse-loamy, mixed, nonacid, mesic Mollic Haplaquepts
Kewaunee	Fine, mixed, mesic Typic Hapludalfs
Kidder	Fine-loamy, mixed, mesic Typic Hapludalfs
Kingsville	Mixed, mesic Mollic Psammaquents
Knowles	Fine-silty, mixed, mesic Typic Hapludalfs
Korobago	Coarse-loamy over clayey, mixed, mesic Aquic Eutrochrepts
Lamartine	Fine-silty, mixed, mesic Aquollic Hapludalfs
LeRoy	Fine-loamy, mixed, mesic Typic Hapludalfs
Lomira	Fine-silty, mixed, mesic Typic Hapludalfs
Lorenzo Variant	Fine-loamy over sandy or sandy-skeletal, mixed, mesic Typic Argiudolls
Manawa	Fine, mixed, mesic Aquollic Hapludalfs
McHenry	Fine-loamy, mixed, mesic Typic Hapludalfs
Menasha	Very fine, mixed, mesic Typic Haplaquolls
*Morocco	Mixed, mesic Aquic Udipsamments
Mosel	Fine-loamy, mixed, mesic Aquollic Hapludalfs
*Navan	Fine-loamy, mixed, mesic Typic Argiaquolls
Nebago	Sandy over clayey, mixed, mesic Aquic Dystric Eutrochrepts
Nebago Variant	Sandy over clayey, mixed, nonacid, mesic Mollic Haplaquepts
Neenah	Very fine, mixed, mesic Aquollic Hapludalfs
Nenno	Fine-loamy, mixed, mesic Aquic Argiudolls
Oakville	Mixed, mesic Typic Udipsamments
Omro	Clayey over loamy, mixed, mesic Typic Hapludalfs
Ossian	Fine-silty, mixed, mesic Typic Haplaquolls
Palms	Loamy, mixed, euic, mesic Terric Medisaprists
Plano	Fine-silty, mixed, mesic Typic Argiudolls
Poy	Clayey over sandy or sandy-skeletal, mixed, mesic Typic Haplaquolls
Poygan	Fine, mixed, mesic Typic Haplaquolls
Puchyan	Loamy, mixed, mesic Arenic Hapludalfs
Ritchey	Loamy, mixed, mesic Lithic Hapludalfs
St. Charles	Fine-silty, mixed, mesic Typic Hapludalfs
Tustin	Clayey, mixed, mesic Arenic Hapludalfs
Udorthents	Loamy, mixed, nonacid, mesic Udorthents
*Wauseon	Coarse-loamy over clayey, mixed, mesic Typic Haplaquolls
Whalan	Fine-loamy, mixed, mesic Typic Hapludalfs
Willette	Clayey, illitic, euic, mesic Terric Medisaprists
Winneconne	Very fine, mixed, mesic Mollic Hapludalfs
Yahara	Coarse-loamy, mixed, mesic Aquic Hapludolls
Zittau	Clayey over sandy or sandy-skeletal, mixed, mesic Aquollic Hapludalfs

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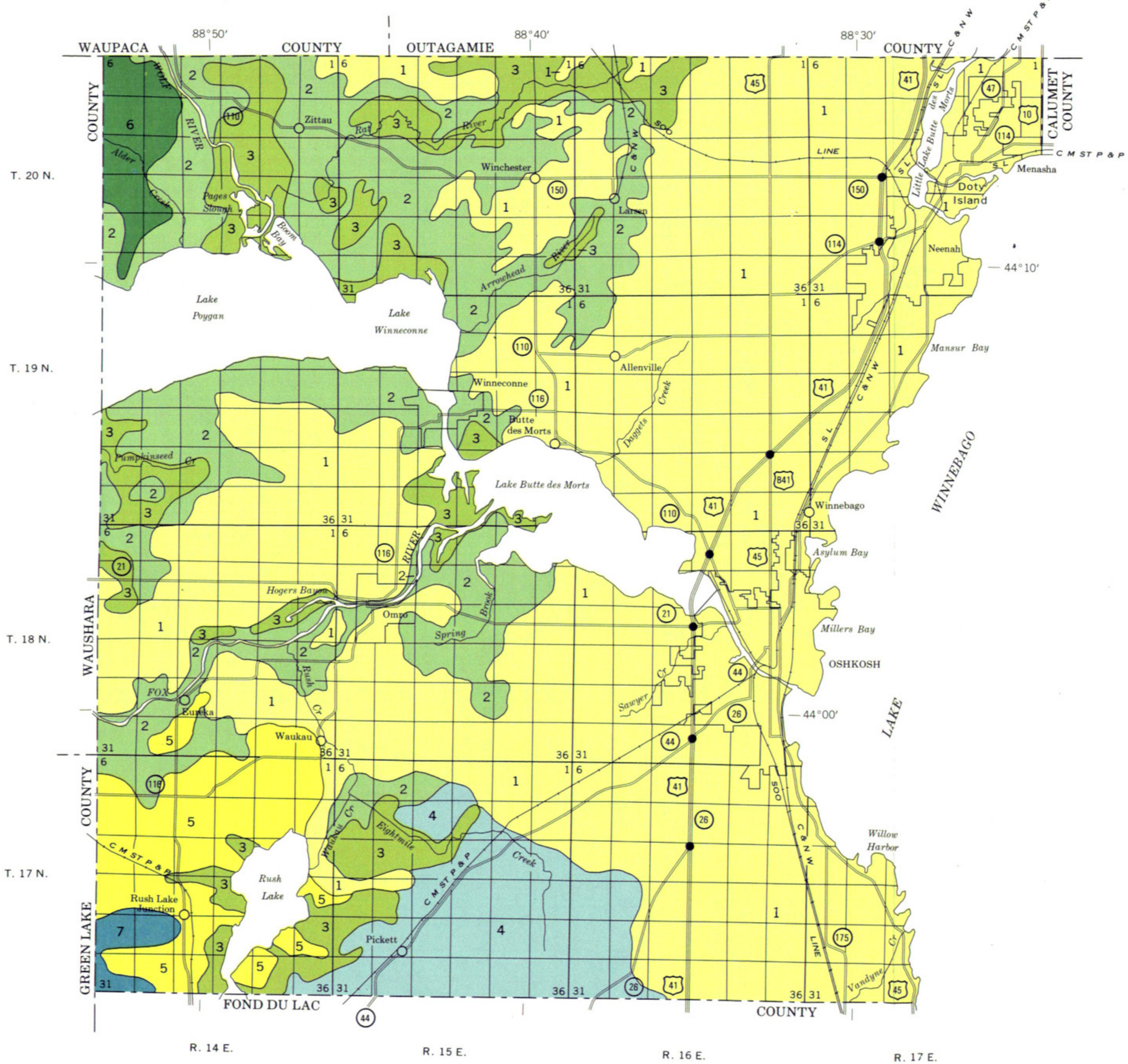
NRCS Accessibility Statement

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
RESEARCH DIVISION OF THE COLLEGE OF AGRICULTURAL AND LIFE SCIENCES,
UNIVERSITY OF WISCONSIN

GENERAL SOIL MAP

WINNEBAGO COUNTY, WISCONSIN

Scale 1:190,080



SOIL LEGEND

1	Kewaunee—Manawa—Hortonville: Well drained to somewhat poorly drained, nearly level to sloping soils that have a loamy or clayey subsoil underlain by loamy or clayey glacial till
2	Zittau—Poy: Somewhat poorly drained and poorly drained, nearly level and gently sloping soils that have a clayey subsoil underlain by sandy material
3	Houghton—Willette: Very poorly drained, nearly level organic soils
4	LeRoy—Ossian—Lomira: Well drained and poorly drained, nearly level to sloping soils that have a silty or loamy subsoil underlain by loamy glacial till or silt loam alluvium
5	Kidder—McHenry: Well drained, gently sloping to moderately steep soils that have a loamy subsoil underlain by loamy glacial till
6	Oakville—Brems—Morocco: Well drained to somewhat poorly drained, nearly level to sloping soils that have a sandy subsoil underlain by sandy material
7	Plano: Well drained, gently sloping soils that have a silty and loamy subsoil underlain by loamy glacial till

Compiled 1979

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

INDEX TO MAP SHEETS

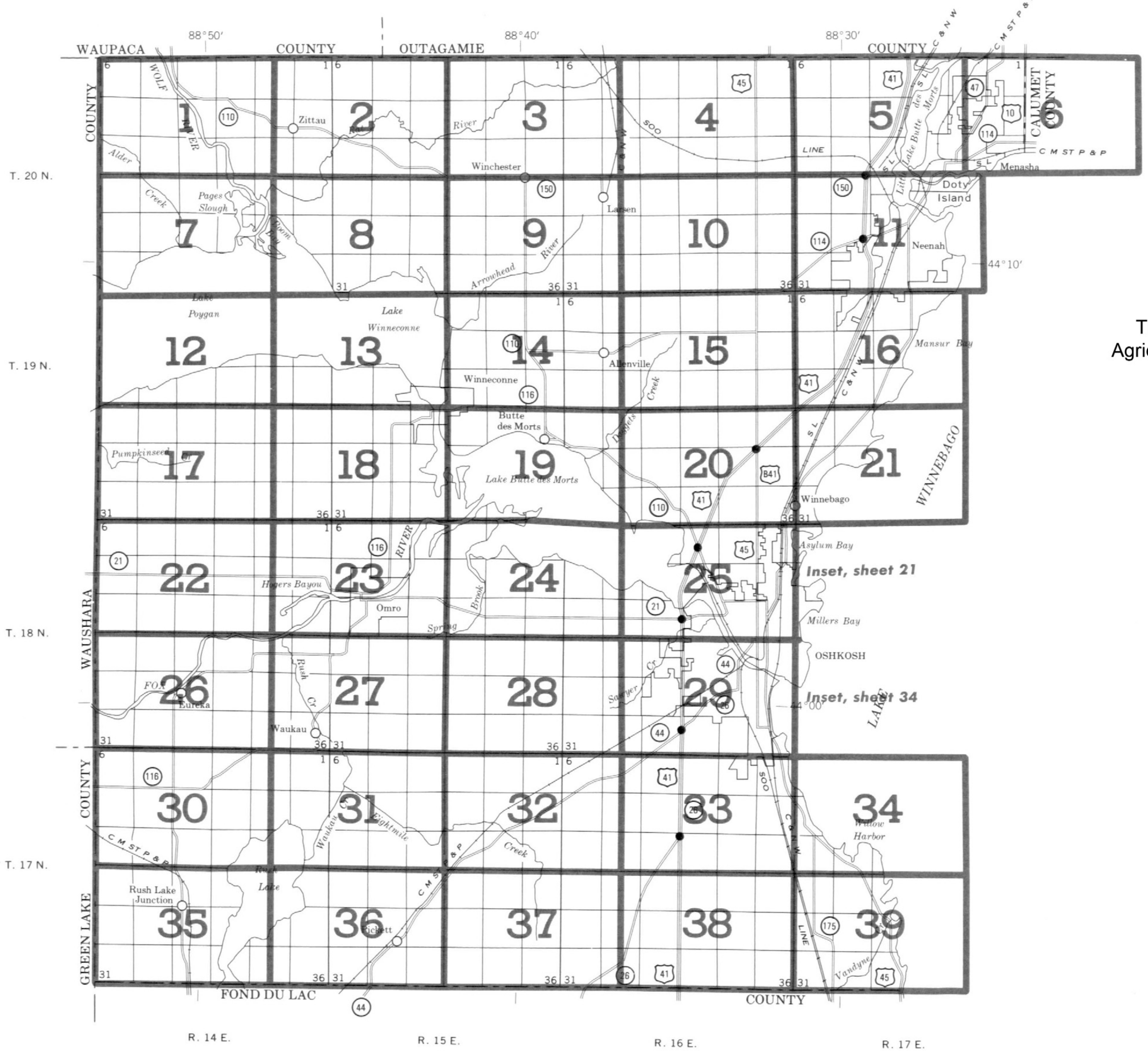
WINNEBAGO COUNTY, WISCONSIN

Scale 1:190,080

1 0 1 2 3 4 Miles

1 0 1 2 3 4 5 6 Kilometers

Original text from each individual map sheet read:
This map is compiled on 1976 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.



SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool — Davis Airstrip; FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate — 79
- Federal — 410
- State — 52
- County, farm or ranch — 378

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small — water; w

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — GAS
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water; w
- Intermittent — int; i

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — CeA FoB2

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

GULLY

DEPRESSION OR SINK

SOIL SAMPLE SITE (normally not shown) — S

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Made land spot
- Sanitary landfill
- Pumping station (drainage)
- Bedrock at a depth of 40 to 60 inches

SOIL LEGEND

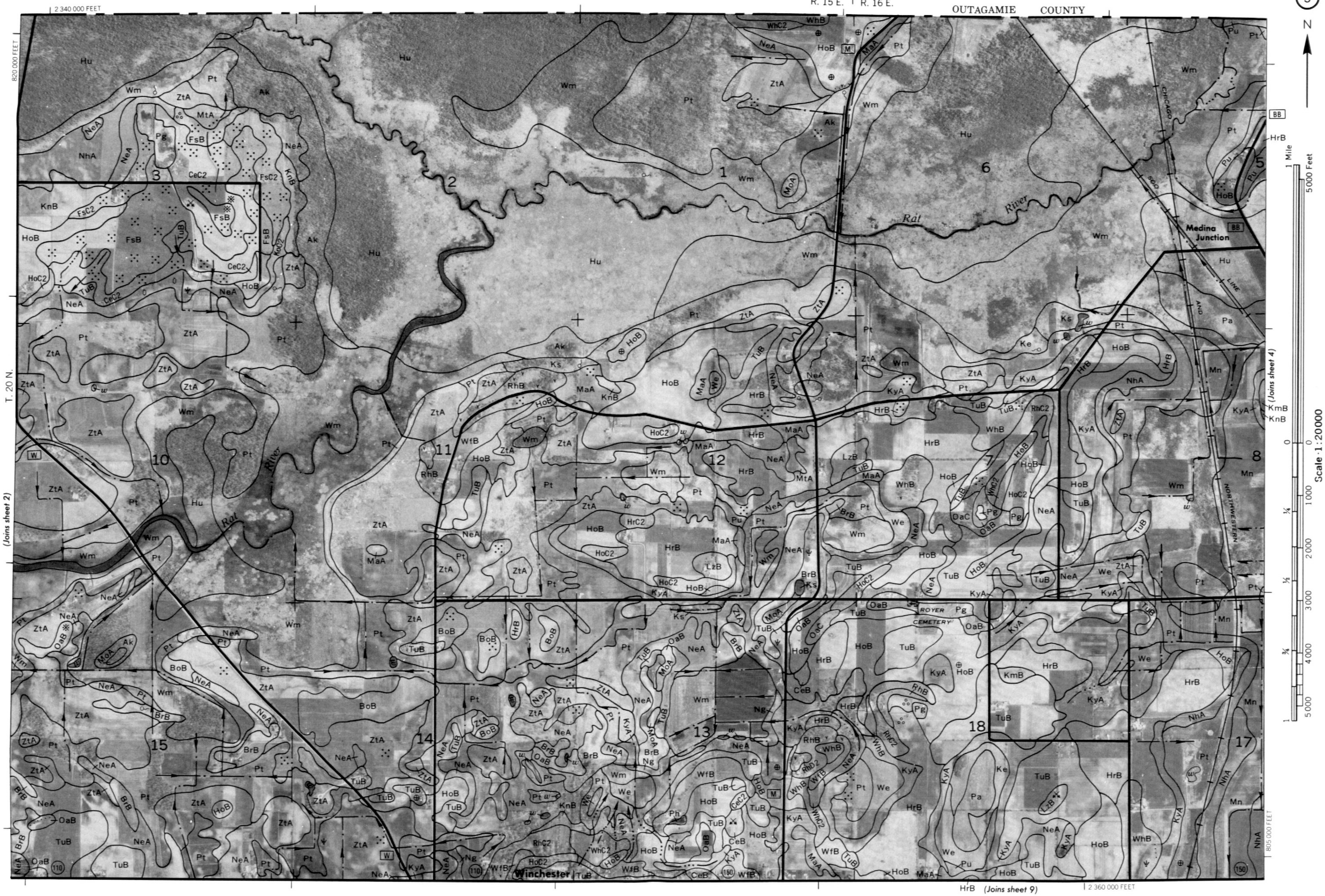
Map symbols consist of a combination of letters or of letters and numbers. The first capital letter is the initial one of the map unit name. The lowercase letter that follows separates map units having names that begin with the same letter, except that it does not separate sloping or eroded phases. The second capital letter indicates the class of slope. Symbols without a slope letter are for nearly level soils or miscellaneous areas. A final number of 2 indicates that the soil is eroded.

SYMBOL	NAME	SYMBOL	NAME
Ak	Adrian muck	LzB	Lorenzo Variant loam, 2 to 8 percent slopes
AtA	Atterberry silt loam, 0 to 3 percent slopes	MaA	Manawa silty clay loam, 0 to 3 percent slopes
BoB	Borth silty clay loam, 1 to 4 percent slopes	MhB	McHenry silt loam, 2 to 6 percent slopes
BrB	Brems fine sand, 1 to 4 percent slopes	MhC2	McHenry silt loam, 6 to 12 percent slopes, eroded
CeB	Casco loam, 2 to 6 percent slopes	Mn	Menasha clay
CeC2	Casco loam, 6 to 15 percent slopes, eroded	MoA	Morocco loamy fine sand, 0 to 3 percent slopes
Ed	Edwards muck	MtA	Mosel silt loam, 0 to 3 percent slopes
ElD2	Eleva loam, 8 to 20 percent slopes, eroded	Na	Navan silt loam
FkA	Fisk loamy fine sand, 0 to 3 percent slopes	NeA	Nebago fine sand, 0 to 3 percent slopes
Fn	Fluvaquents	Ng	Nebago Variant mucky loamy fine sand
FsB	Fox silt loam, 2 to 6 percent slopes	NhA	Neenah silty clay loam, 0 to 3 percent slopes
FsC2	Fox silt loam, 6 to 12 percent slopes, eroded	NnA	Nenno loam, 0 to 3 percent slopes
GnB	Grellton fine sandy loam, 2 to 6 percent slopes	OaB	Oakville fine sand, 2 to 6 percent slopes
HmB	Hochheim loam, 2 to 6 percent slopes	OaC	Oakville fine sand, 6 to 12 percent slopes
HoB	Hortonville loamy fine sand, 2 to 6 percent slopes	OmB	Omro clay loam, 2 to 6 percent slopes
HoC2	Hortonville loamy fine sand, 6 to 12 percent slopes, eroded	Os	Ossian silt loam
HrB	Hortonville silt loam, 2 to 6 percent slopes	Pa	Palms muck
HrC2	Hortonville silt loam, 6 to 12 percent slopes, eroded	Pg	Pits, gravel
Hu	Houghton muck	Ph	Pits, quarries
Hw	Houghton muck, ponded	PsB	Plano silt loam, 2 to 6 percent slopes
KaB	Kaukauna silty clay loam, 1 to 4 percent slopes	Pt	Poy silty clay loam
Ke	Keowns silt loam	Pu	Poygan silty clay loam
KmB	Kewaunee loamy fine sand, 2 to 6 percent slopes	PzB	Puchyan loamy fine sand, 2 to 6 percent slopes
KnB	Kewaunee silt loam, 2 to 6 percent slopes	RhB	Ritchey silt loam, 2 to 6 percent slopes
KoC2	Kewaunee silty clay loam, 6 to 12 percent slopes, eroded	RhC2	Ritchey silt loam, 6 to 12 percent slopes, eroded
KpB	Kidder loamy fine sand, 2 to 6 percent slopes	RhD2	Ritchey silt loam, 12 to 30 percent slopes, eroded
KpC2	Kidder loamy fine sand, 6 to 12 percent slopes, eroded	ScB	St. Charles silt loam, 2 to 6 percent slopes
KrB	Kidder silt loam, 2 to 6 percent slopes	TuB	Tustin fine sand, 2 to 6 percent slopes
KrC2	Kidder silt loam, 6 to 15 percent slopes, eroded	UoA	Udorthents, 0 to 3 percent slopes
Ks	Kingsville mucky loamy fine sand	We	Wauseon silt loam
KwB	Knowles silt loam, 2 to 6 percent slopes	WfB	Whalan loamy fine sand, 2 to 8 percent slopes
KwC2	Knowles silt loam, 6 to 12 percent slopes, eroded	WhB	Whalan silt loam, 2 to 6 percent slopes
KyA	Korobago silt loam, 0 to 3 percent slopes	WhC2	Whalan silt loam, 6 to 12 percent slopes, eroded
LmA	Lamartine silt loam, 0 to 3 percent slopes	Wm	Willette muck
LrB	LeRoy silt loam, 2 to 6 percent slopes	WnB	Winneconne silty clay loam, 1 to 4 percent slopes
LrC2	LeRoy silt loam, 6 to 12 percent slopes, eroded	YaA	Yahara silt loam, 0 to 3 percent slopes
LvB	Lomira silt loam, 2 to 6 percent slopes	ZtA	Zittau silty clay loam, 0 to 3 percent slopes


1
N
WAUPACA COUNTY
WAUSHARA COUNTY
R. 14 E.
T. 20 N.
2 295 000 FEET
815 000 FEET
805 000 FEET
2 315 000 FEET
WOLF RIVER
WOLF RIVER CEMETERY
BECKER CEMETERY
ST PAULS CEMETERY
Orihula
Metz
Alder Creek
Boom Island
water
(Joins sheet 2)
(Joins sheet 7)
Scale 1:20000
1 Mile
5000 Feet

②

WINNEBAGO COUNTY, WISCONSIN — SHEET NUMBER 2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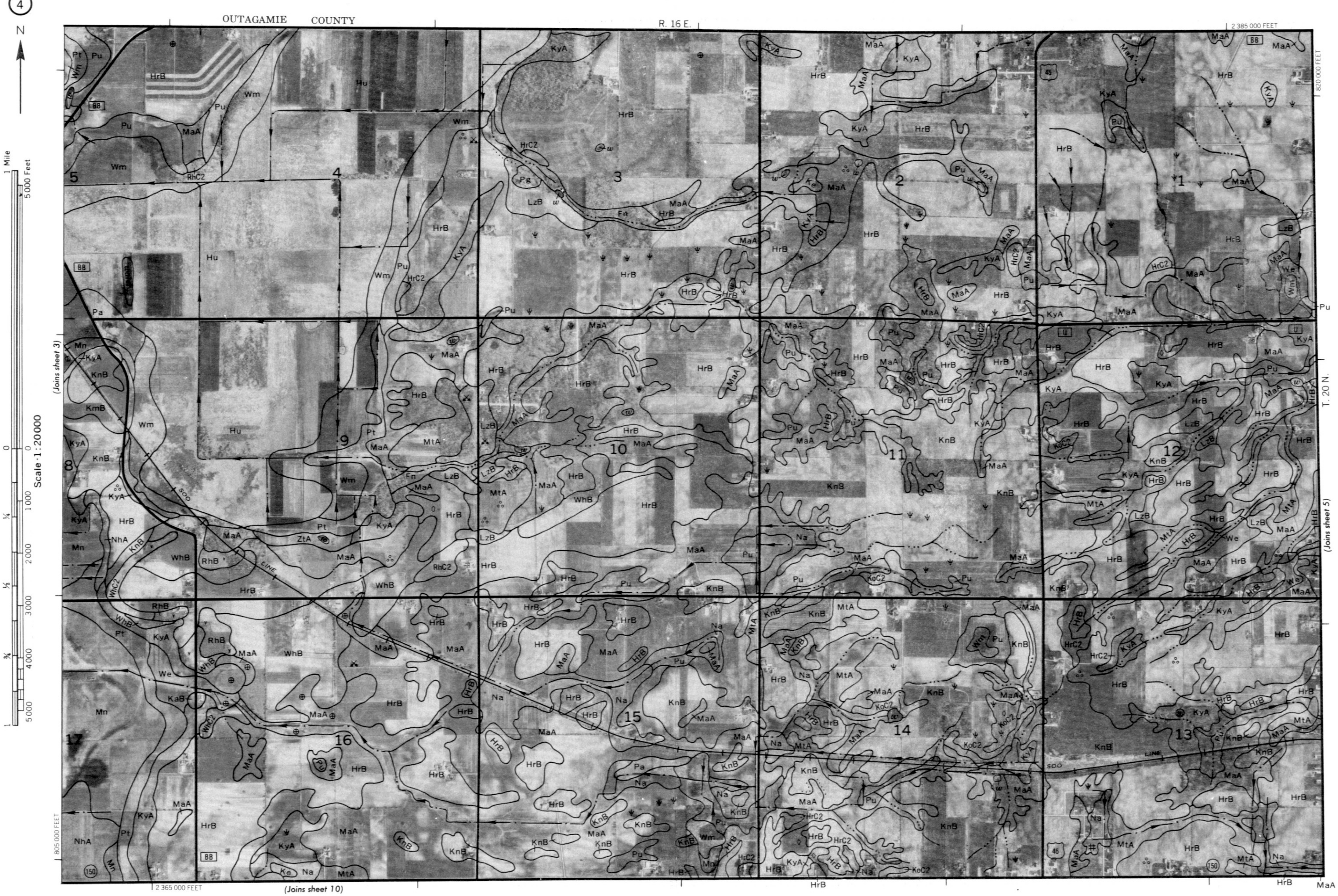
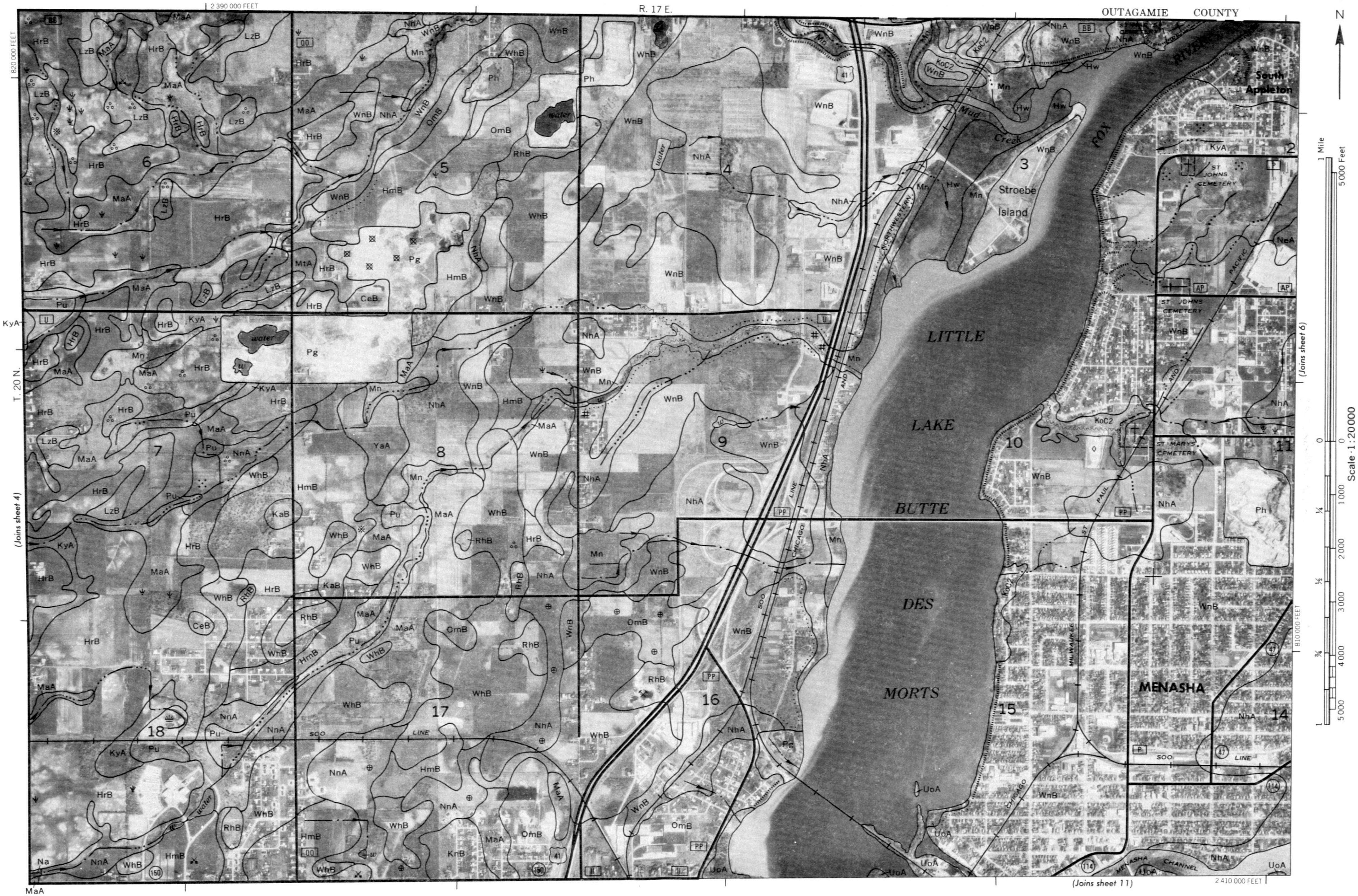
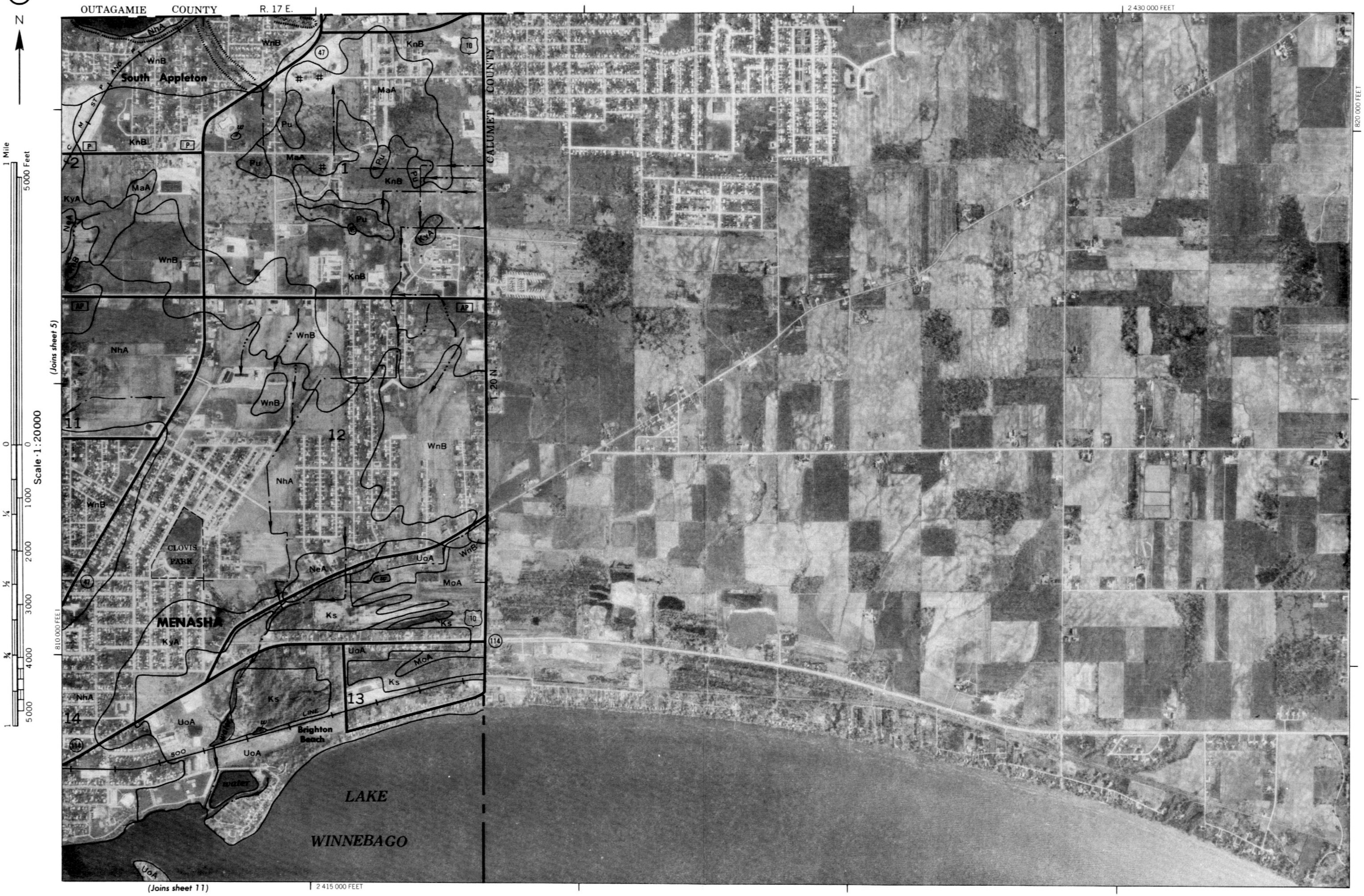
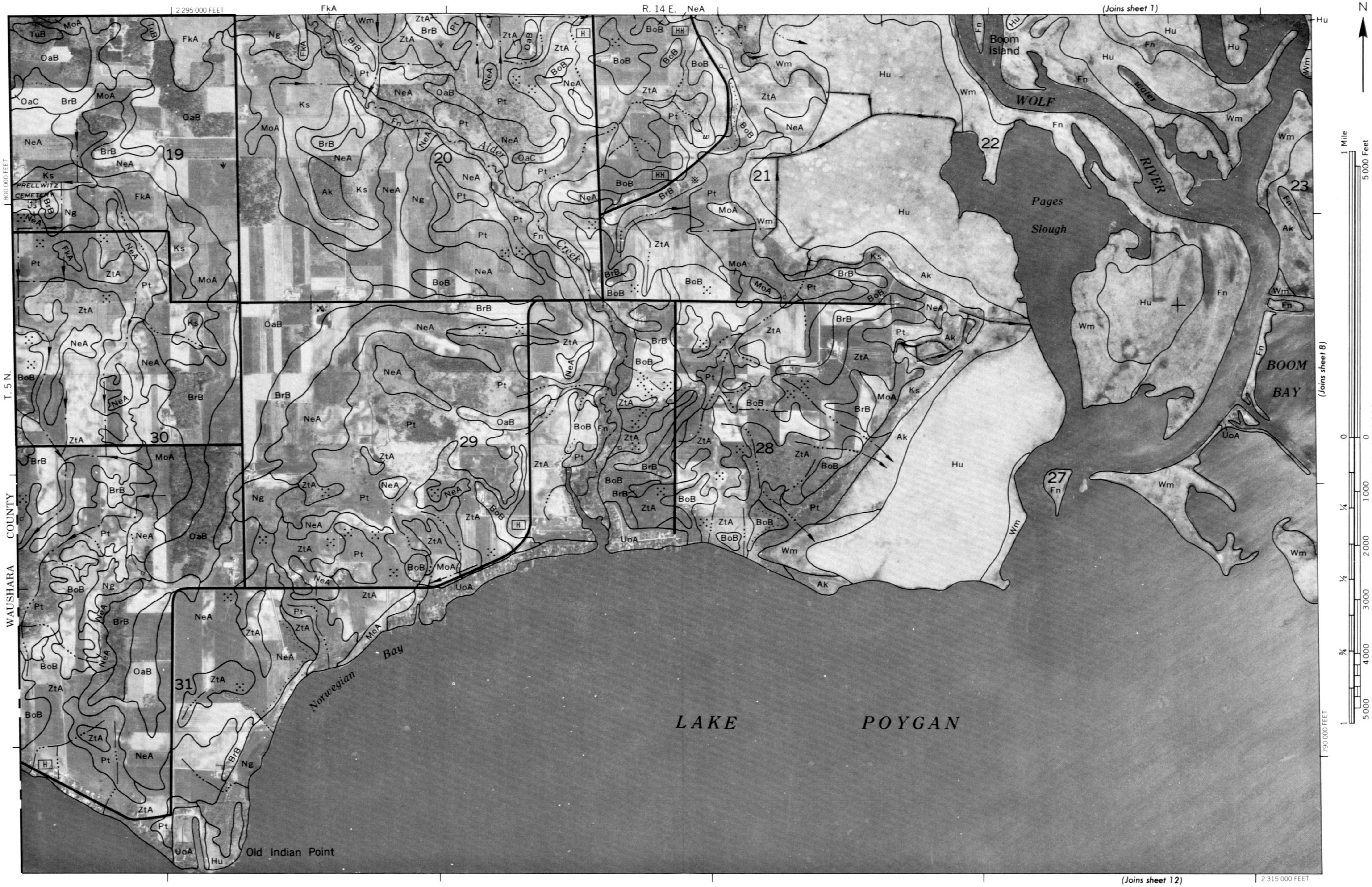
820 000 FEET
805 000 FEET
2 360 000 FEET
R. 15 E.
R. 16 E.
OUTAGAMIE COUNTY
T. 20 N.
(Joins sheet 2)
(Joins sheet 4)
(Joins sheet 9)
Rat River
Medina Junction
CHICAGO AND NORTHWESTERN
SOO LINE
ROYER CEMETERY
Winchester
1 Mile
5000 Feet
Scale 1:20000


4
N
OUTAGAMIE COUNTY
R. 16 E.
T. 20 N.
2 385 000 FEET
820 000 FEET
805 000 FEET
2 365 000 FEET
(Joins sheet 3)
(Joins sheet 5)
(Joins sheet 10)
Scale 1:20000
1 Mile
5000 Feet
SOO LINE

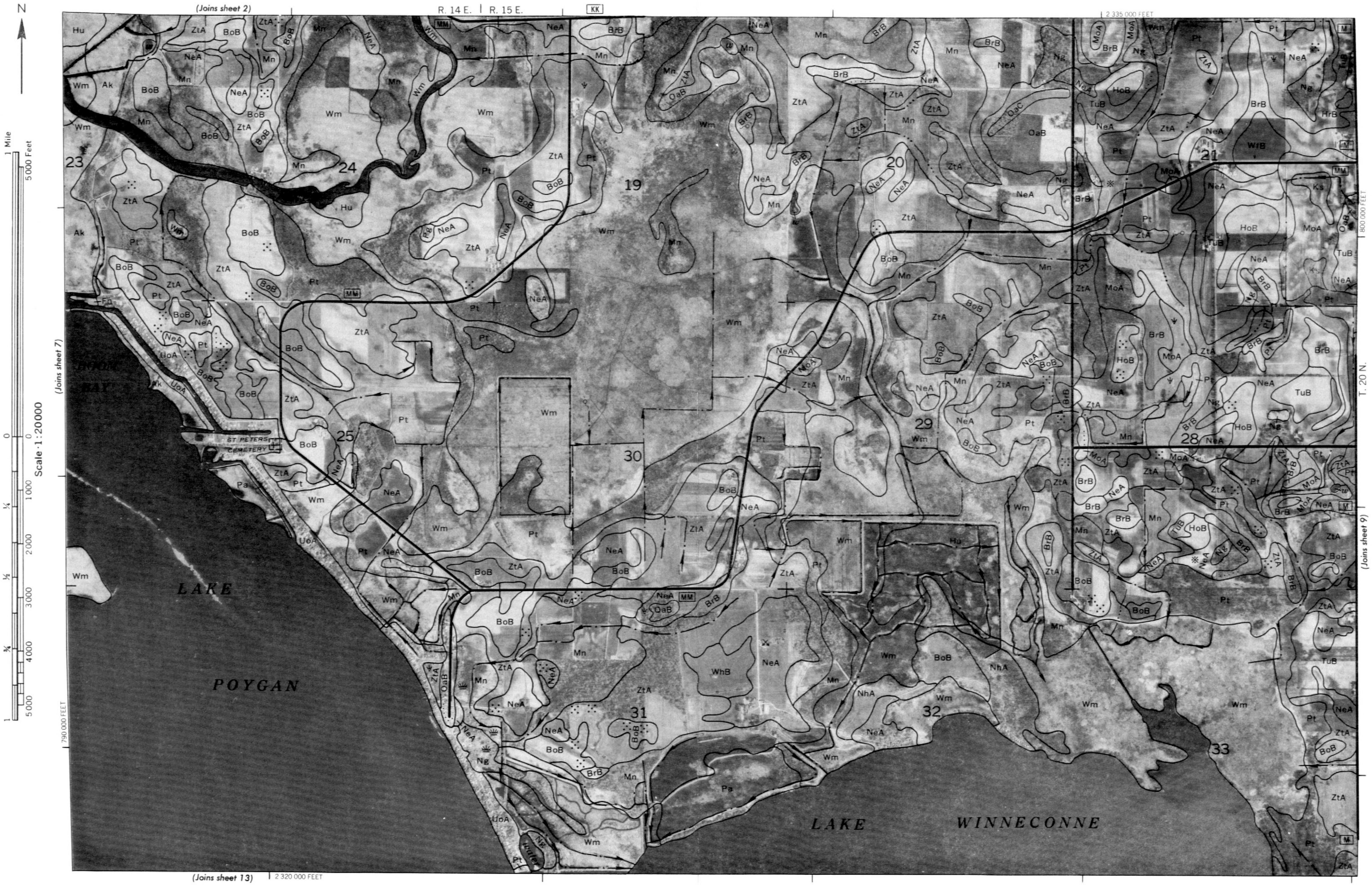


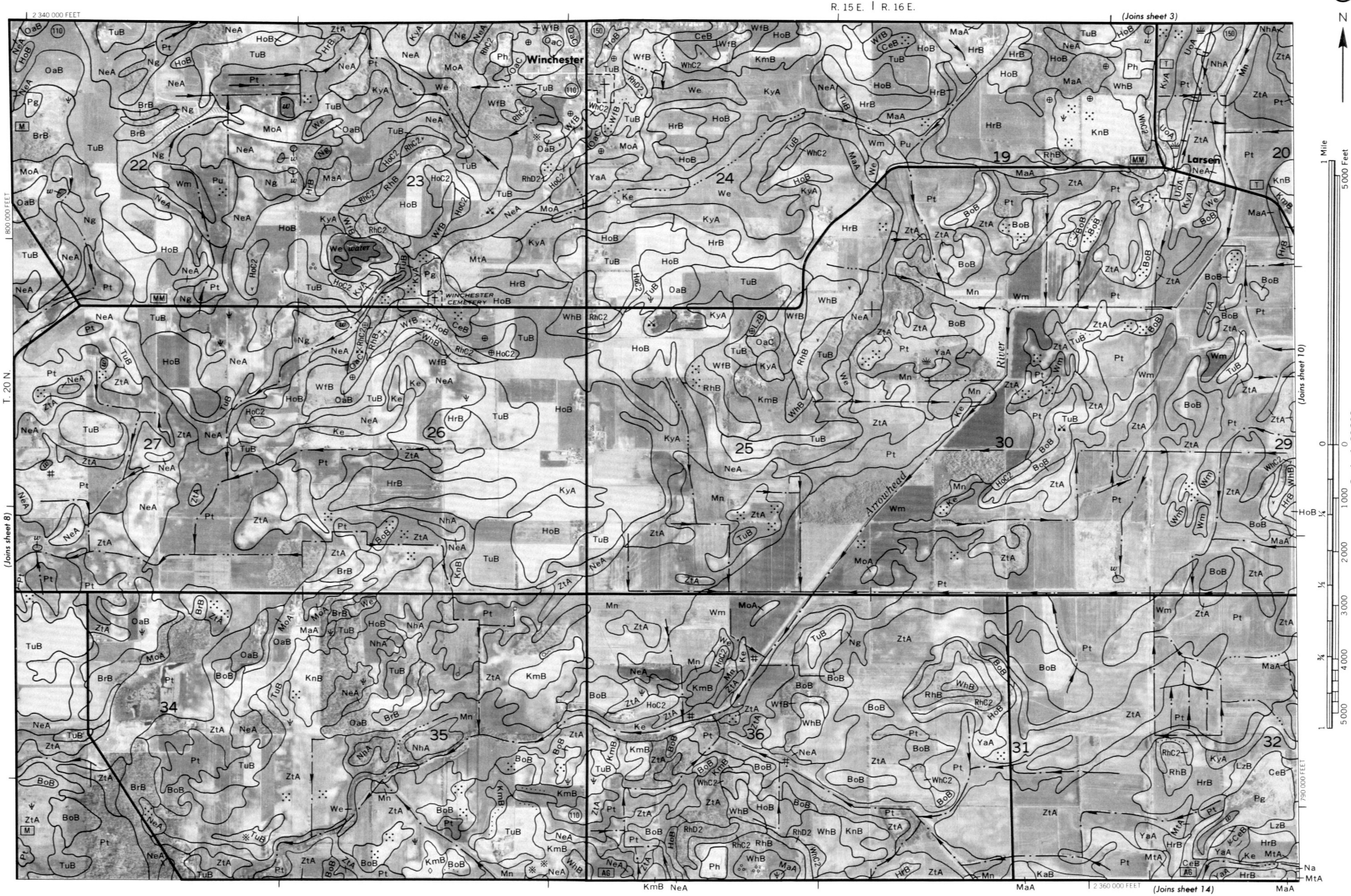
2 390 000 FEET
R. 17 E.
OUTAGAMIE COUNTY
N
820 000 FEET
T. 20 N.
(Joins sheet 4)
(Joins sheet 6)
(Joins sheet 11)
South Appleton
Stroebe Island
Mud Creek
FOX RIVER
LITTLE LAKE BUTTE DES MORTS
MENASHA
ST JOHNS CEMETERY
ST MARYS CEMETERY
MENASHA CHANNEL
NORTHWESTERN
CHICAGO AND NORTHWESTERN
SOO LINE
MILWAUKEE ST PAUL AND PACIFIC
810 000 FEET
2 410 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0 1000 2000 3000 4000 5000
0 ¼ ½ ¾ 1


OUTAGAMIE COUNTY
R. 17 E.
2 430 000 FEET
820 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
810 000 FEET
2 415 000 FEET
(Joins sheet 5)
(Joins sheet 11)
CALUMET COUNTY
T. 20 N.
South Appleton
MENASHA
CLOVIS PARK
Brighton Beach
LAKE
WINNEBAGO
water
SOO LINE
NhA
WnB
KnB
MaA
Pu
KyA
NeA
UoA
MoA
Ks
47
10
114
AP
P
1
2
11
12
13
14

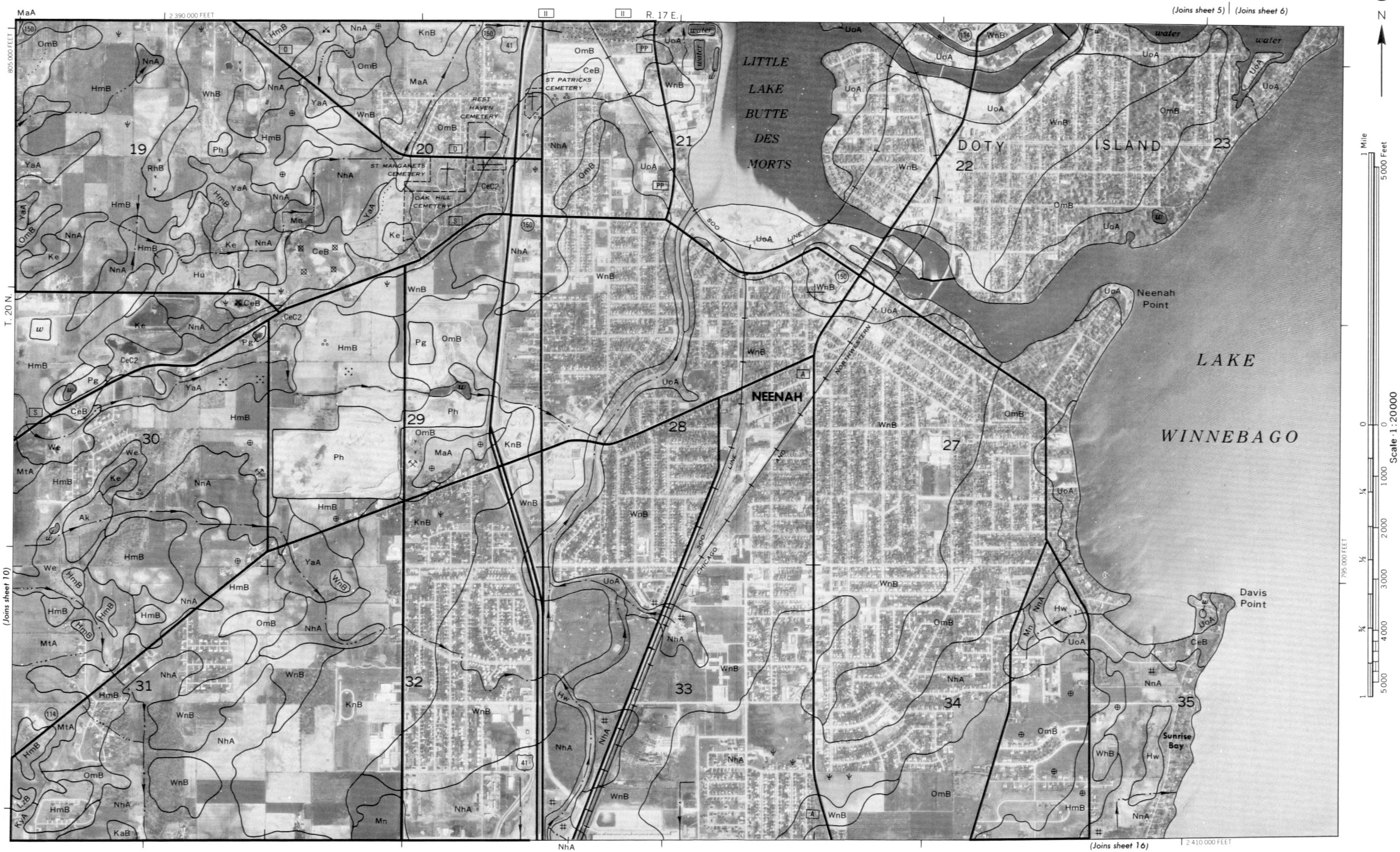

2 295 000 FEET
R. 14 E.
(Joins sheet 1)
(Joins sheet 8)
(Joins sheet 12)
2 315 000 FEET
800 000 FEET
790 000 FEET
T. 5 N.
WAUSHARA COUNTY
N
1 Mile
5000 Feet
Scale 1:20000
Boom Island
WOLF RIVER
water
Pages Slough
BOOM BAY
Alder Creek
PRELLWITZ CEMETERY
Norwegian Bay
LAKE POYGAN
Old Indian Point
19
20
21
22
23
27
28
29
30
31

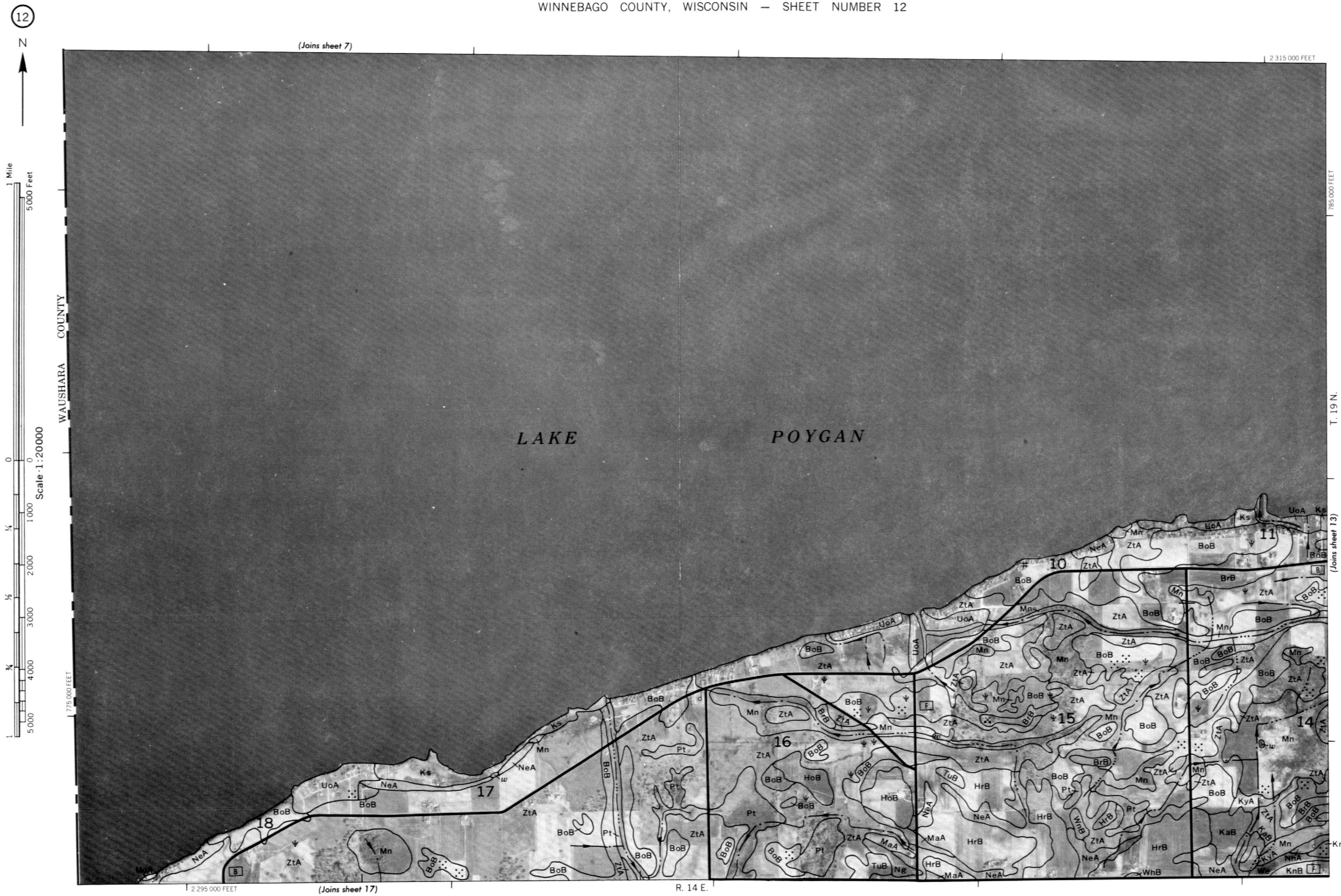
WINNEBAGO COUNTY, WISCONSIN — SHEET NUMBER 8

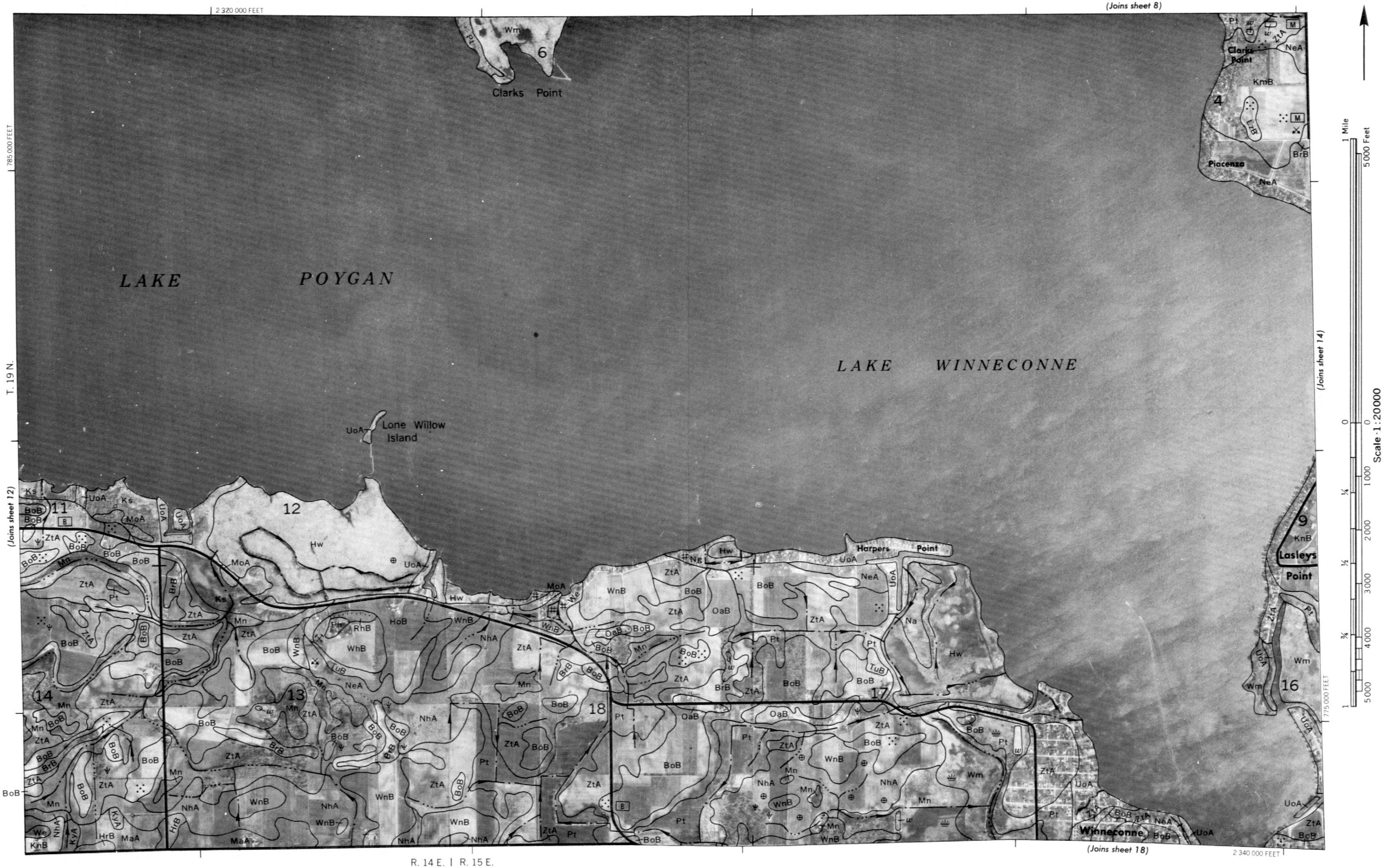


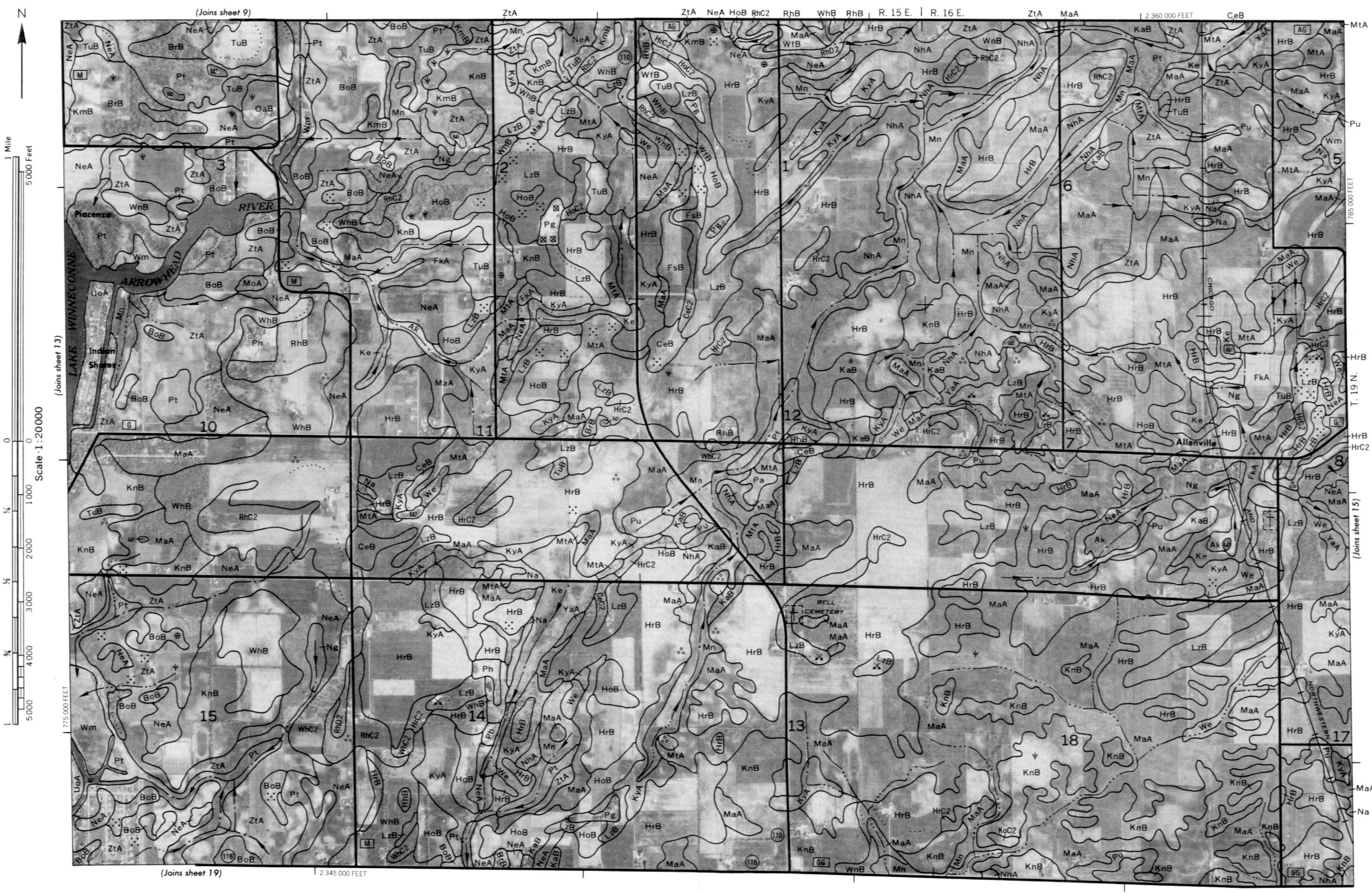

R. 15 E. | R. 16 E.
(Joins sheet 3)
(Joins sheet 8)
(Joins sheet 10)
(Joins sheet 14)
T. 20 N.
2 340 000 FEET
800 000 FEET
790 000 FEET
2 360 000 FEET
Winchester
Larsen
WINCHESTER CEMETERY
Arrowhead River
water
19
20
22
23
24
25
26
27
29
30
31
32
34
35
36
N
1 Mile
5000 Feet
Scale 1:20 000

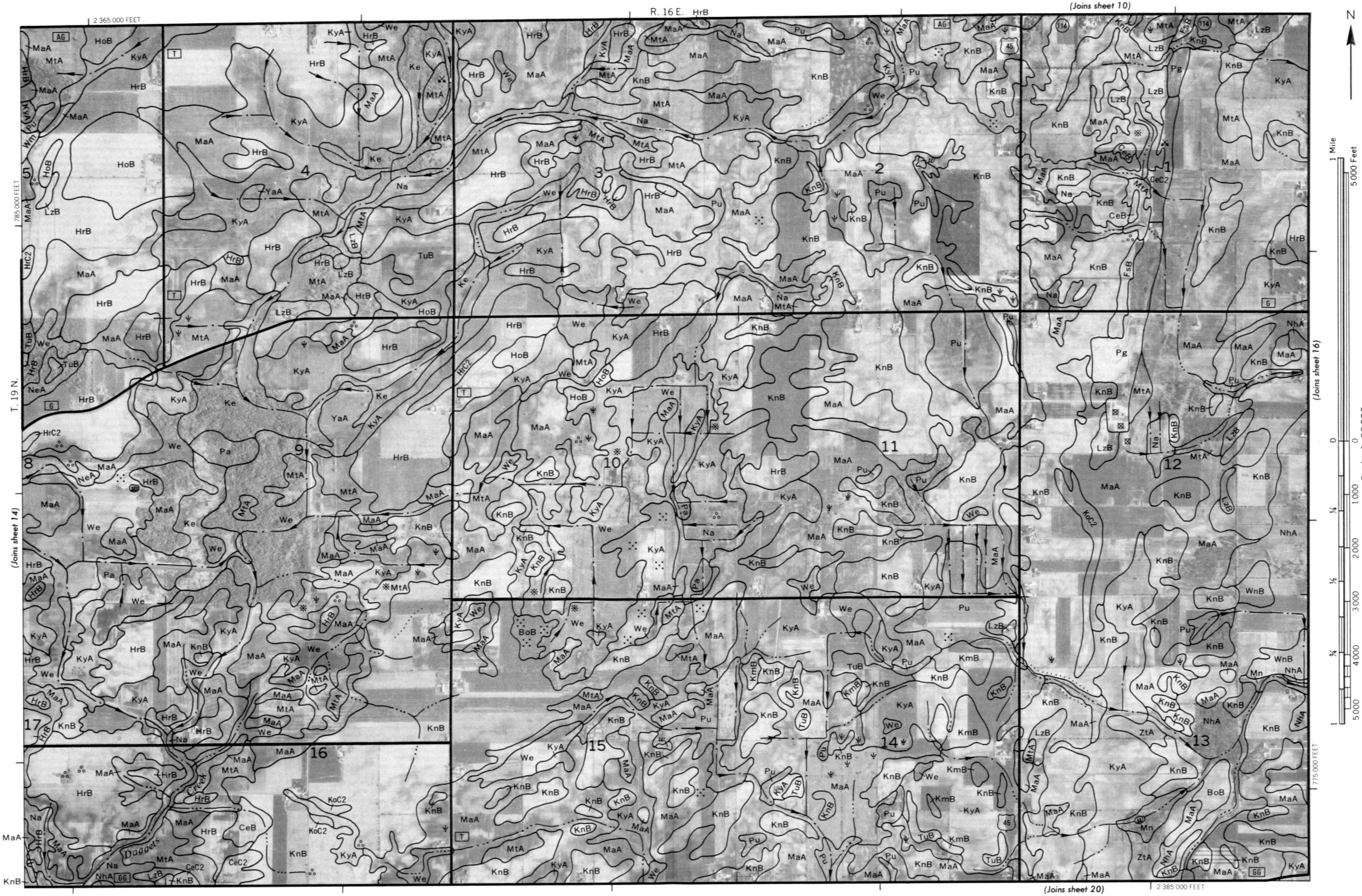

N
(Joins sheet 4)
R. 16 E.
2 385 000 FEET
805 000 FEET
(Joins sheet 9)
T. 20 N.
(Joins sheet 11)
(Joins sheet 15)
2 365 000 FEET
790 000 FEET
Scale 1:20000
1 Mile
5000 Feet
CLAYTON CEMETERY
Mikesville
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36

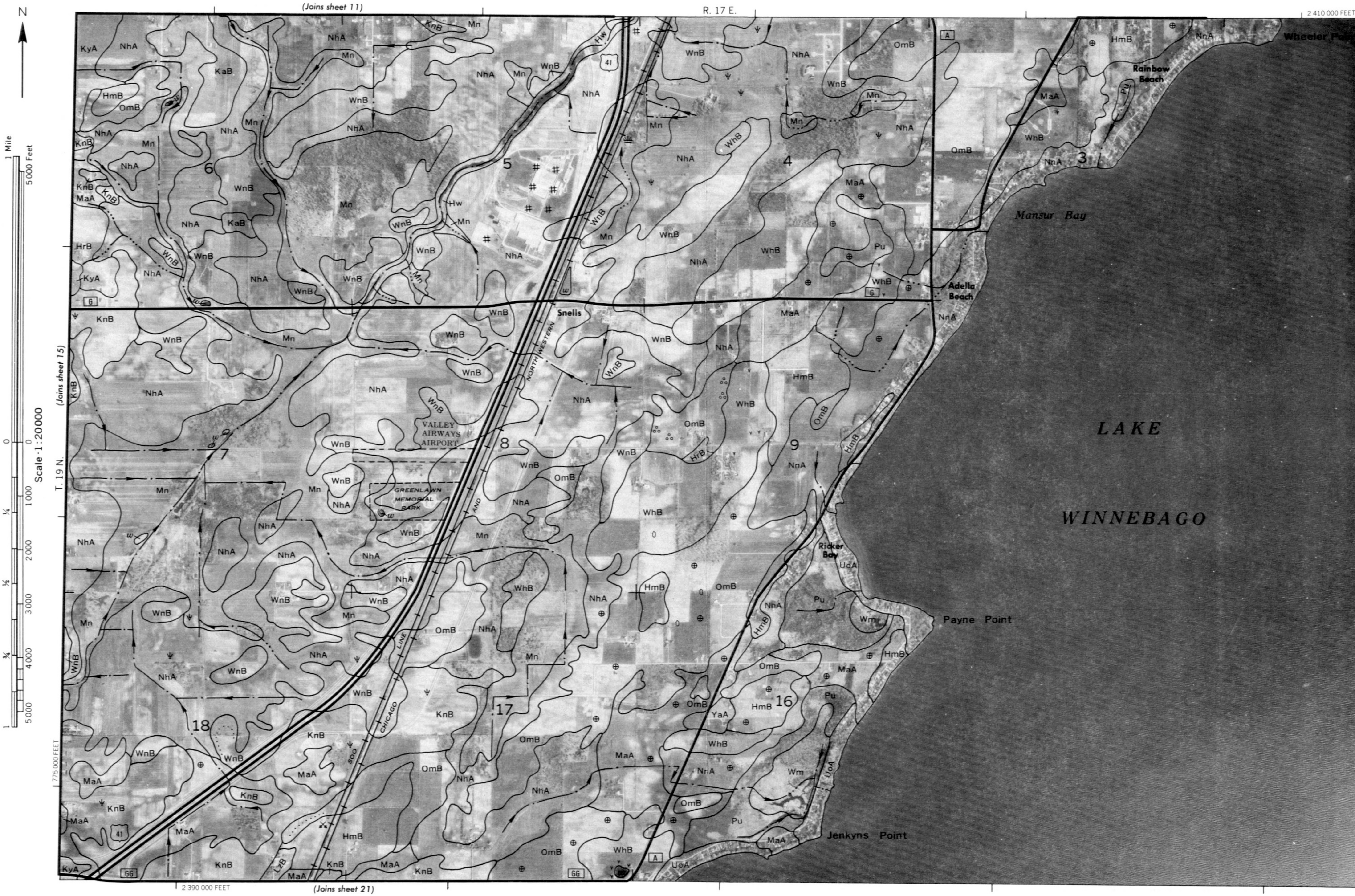

11
N
(Joins sheet 5)
(Joins sheet 6)
(Joins sheet 10)
(Joins sheet 16)
2 390 000 FEET
2 410 000 FEET
805 000 FEET
795 000 FEET
R. 17 E.
T. 20 N.
LITTLE LAKE BUTTE DES MORTS
DOTY ISLAND
NEENAH
LAKE WINNEBAGO
Neenah Point
Davis Point
Sunrise Bay
ST PATRICKS CEMETERY
REST HAVEN CEMETERY
ST MARGARETS CEMETERY
OAK HILL CEMETERY
SOO LINE
CHICAGO AND NORTHWESTERN
water
19
20
21
22
23
27
28
29
30
31
32
33
34
35
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1

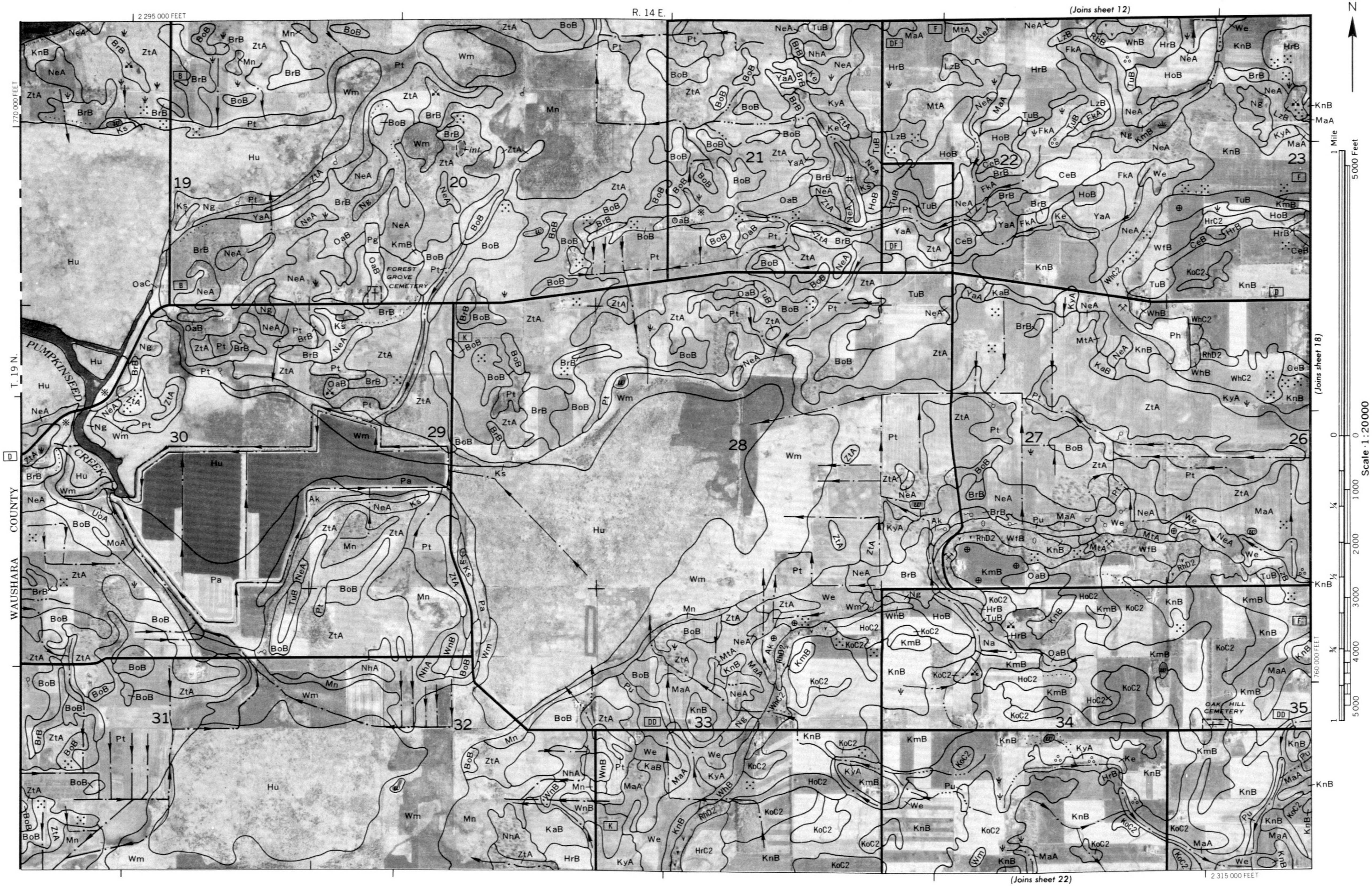

12
N
(Joins sheet 7)
2 315 000 FEET
785 000 FEET
WAUSHARA COUNTY
Scale 1:20000
1 Mile
5000 Feet
LAKE POYGAN
T. 19 N.
(Joins sheet 13)
775 000 FEET
2 295 000 FEET
(Joins sheet 17)
R. 14 E.
10
11
14
15
16
17
18

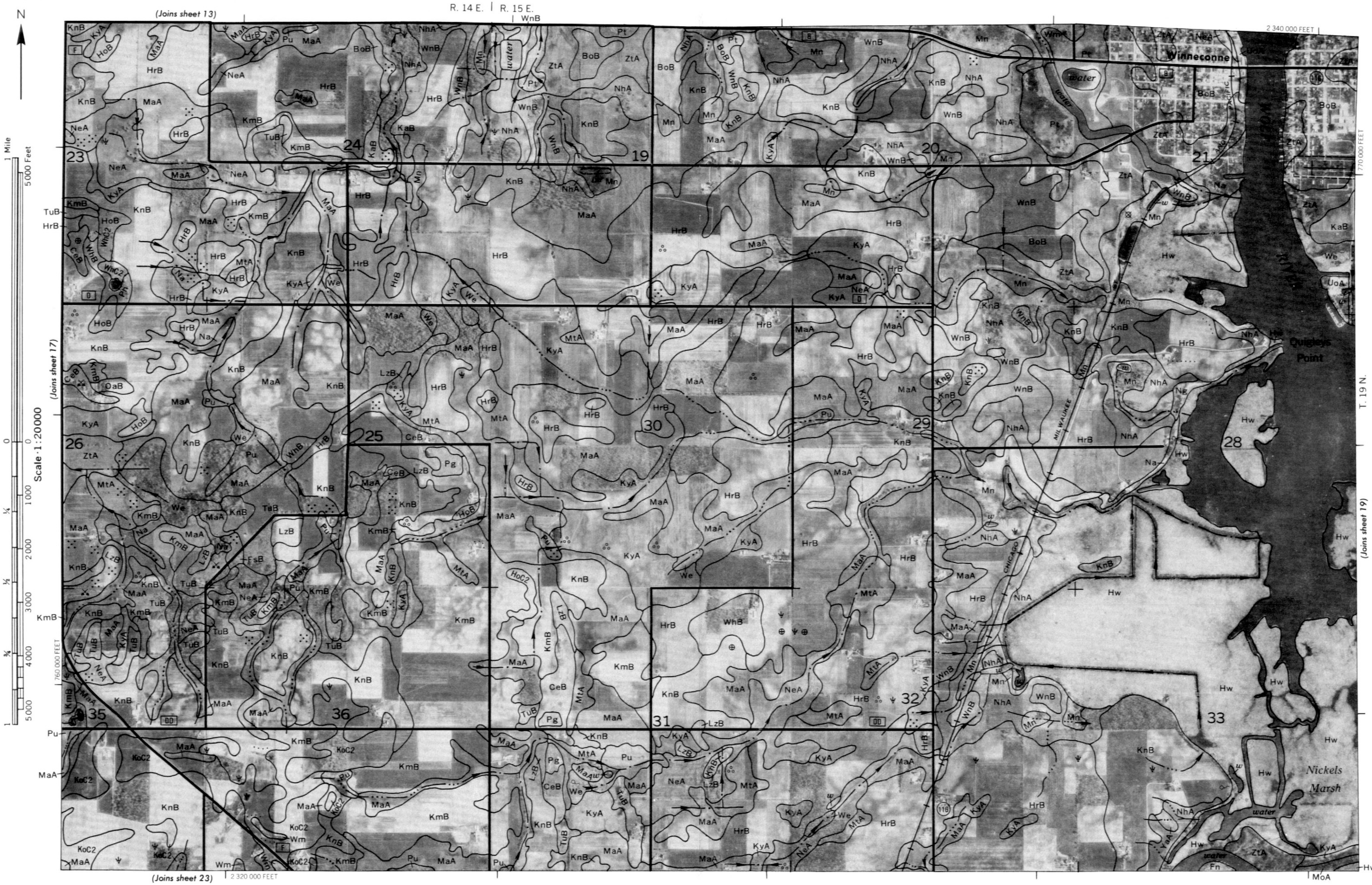

2 320 000 FEET
(Joins sheet 8)
N
Clarks Point
Clarks Point
Piacenza
785 000 FEET
LAKE POYGAN
LAKE WINNECONNE
T. 19 N.
Lone Willow Island
(Joins sheet 12)
(Joins sheet 14)
Harpers Point
Lasleys Point
Winneconne
775 000 FEET
(Joins sheet 18)
2 340 000 FEET
R. 14 E. | R. 15 E.
1 Mile
5000 Feet
Scale 1:20000
0
¼
½
¾
1
0
1000
2000
3000
4000
5000
Wm
Pt
ZtA
NeA
KmB
BrB
Hw
UoA
MoA
Ks
BoB
Mn
WnB
NhA
OaB
TuB
WhB
RhB
HoB
BrB
We
Na
KnB
HrB
MaA
KyA
Ng

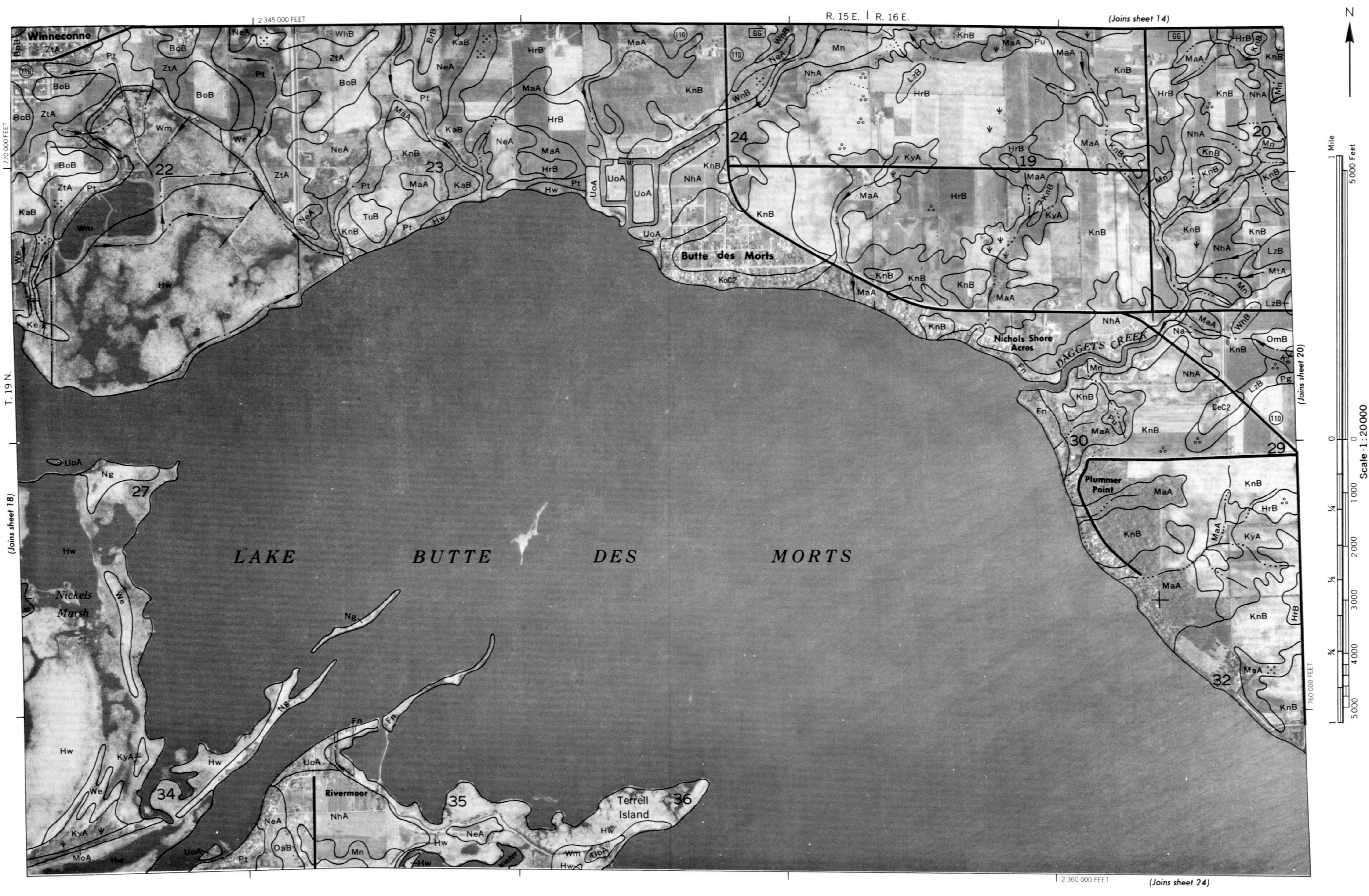

N
(Joins sheet 9)
(Joins sheet 13)
(Joins sheet 15)
(Joins sheet 19)
R. 15 E. | R. 16 E.
T. 19 N.
2 360 000 FEET
785 000 FEET
775 000 FEET
2 345 000 FEET
Scale 1:20000
1 Mile
5000 Feet
LAKE WINNECONNE
ARROWHEAD
RIVER
Piacenza
Indian Shores
Allenville
BELL CEMETERY
CHICAGO AND NORTHWESTERN
1
2
3
5
6
7
8
10
11
12
13
14
15
17
18

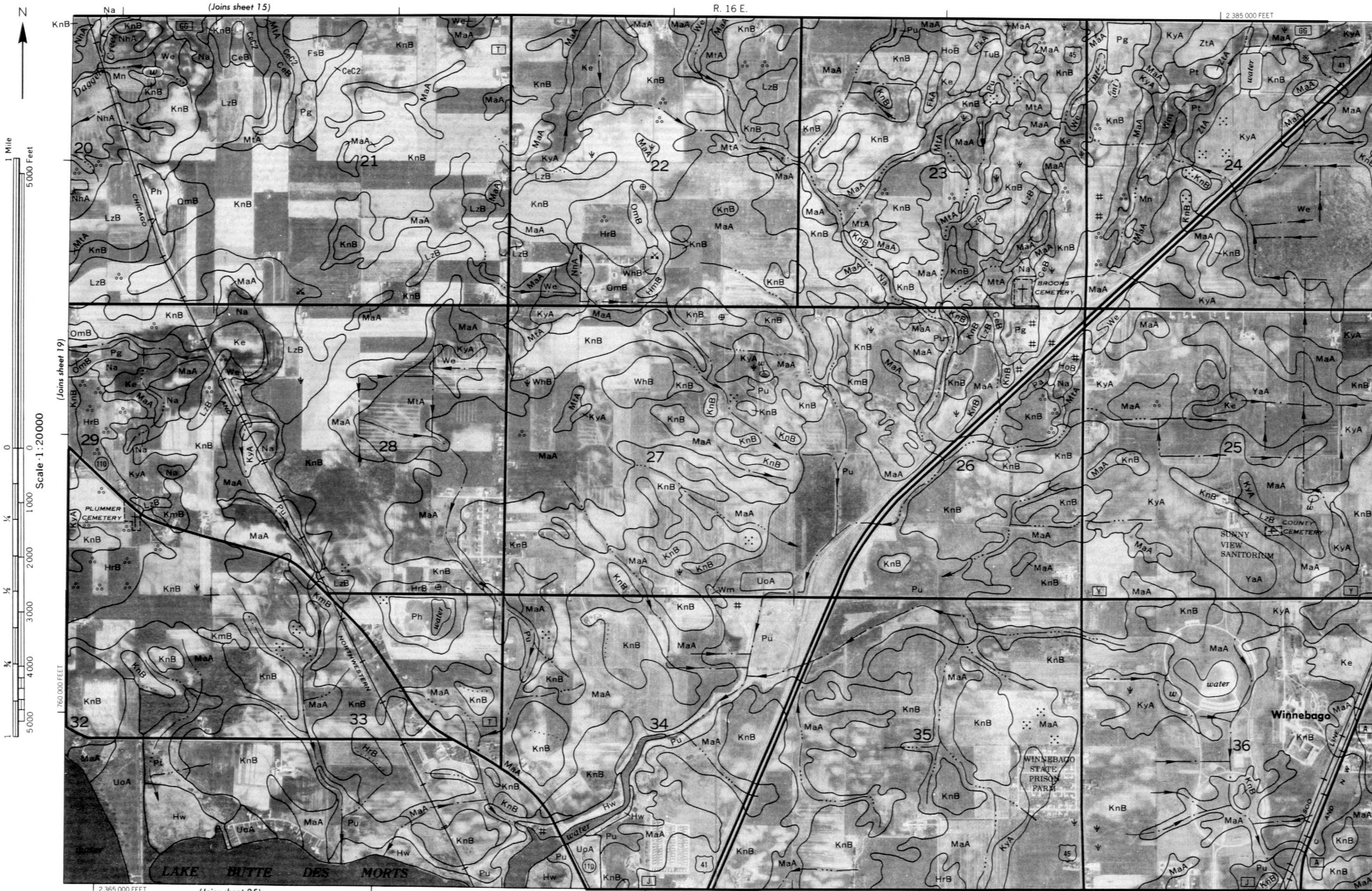

(Joins sheet 10)
(Joins sheet 16)
(Joins sheet 20)
(Joins sheet 14)
R. 16 E.
T. 19 N.
2 365 000 FEET
785 000 FEET
775 000 FEET
2 385 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
Daggets Creek


N
1 Mile
5000 Feet
Scale 1:20000
0
¼
½
¾
1
0
1000
2000
3000
4000
5000
(Joins sheet 11)
R. 17 E.
2 410 000 FEET
790 000 FEET
(Joins sheet 15)
T. 19 N.
775 000 FEET
2 390 000 FEET
(Joins sheet 21)
LAKE
WINNEBAGO
Wheeler Point
Rainbow Beach
Mansur Bay
Adella Beach
Snells
Ricker Bay
Payne Point
Jenkyns Point
VALLEY AIRWAYS AIRPORT
GREENLAWN MEMORIAL PARK
CHICAGO AND NORTH WESTERN LINE
SOO
41
A
G
GG
3
4
5
6
7
8
9
16
17
18


2 295 000 FEET
R. 14 E.
(Joins sheet 12)
N
770 000 FEET
T. 19 N.
WAUSHARA COUNTY
PUMPKINSEED CREEK
FOREST GROVE CEMETERY
OAK HILL CEMETERY
(Joins sheet 18)
(Joins sheet 22)
760 000 FEET
2 315 000 FEET
19
20
21
22
23
30
29
28
27
26
31
32
33
34
35
1 Mile
5000 Feet
Scale 1:20000


N
(Joins sheet 13)
R. 14 E. | R. 15 E.
(Joins sheet 17)
(Joins sheet 19)
(Joins sheet 23)
T. 19 N.
1 Mile
5000 Feet
Scale 1:20000
2 340 000 FEET
770 000 FEET
760 000 FEET
2 320 000 FEET
Winneconne
Quigleys Point
Nickels Marsh
MILWAUKEE
CHICAGO
23
24
19
20
21
26
25
30
29
28
35
36
31
32
33


(Joins sheet 14)
(Joins sheet 18)
(Joins sheet 20)
(Joins sheet 24)
R. 15 E. | R. 16 E.
T. 19 N.
2 345 000 FEET
2 360 000 FEET
770 000 FEET
760 000 FEET
Winneconne
Butte des Morts
Nichols Shore Acres
DAGGETS CREEK
Plummer Point
LAKE BUTTE DES MORTS
Nickels Marsh
Rivermoor
Terrell Island
N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1


(Joins sheet 15)
R. 16 E.
2 385 000 FEET
770 000 FEET
T. 19 N.
(Joins sheet 21)
(Joins sheet 19)
(Joins sheet 25)
2 365 000 FEET
760 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
Dagget Creek
CHICAGO
NORTHWESTERN
PLUMMER CEMETERY
BROOKS CEMETERY
SUNNY VIEW SANITORIUM
COUNTY CEMETERY
WINNEBAGO STATE PRISON FARM
Winnebago
LAKE BUTTE DES MORTS
SOO LINE
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36

R. 17 E.

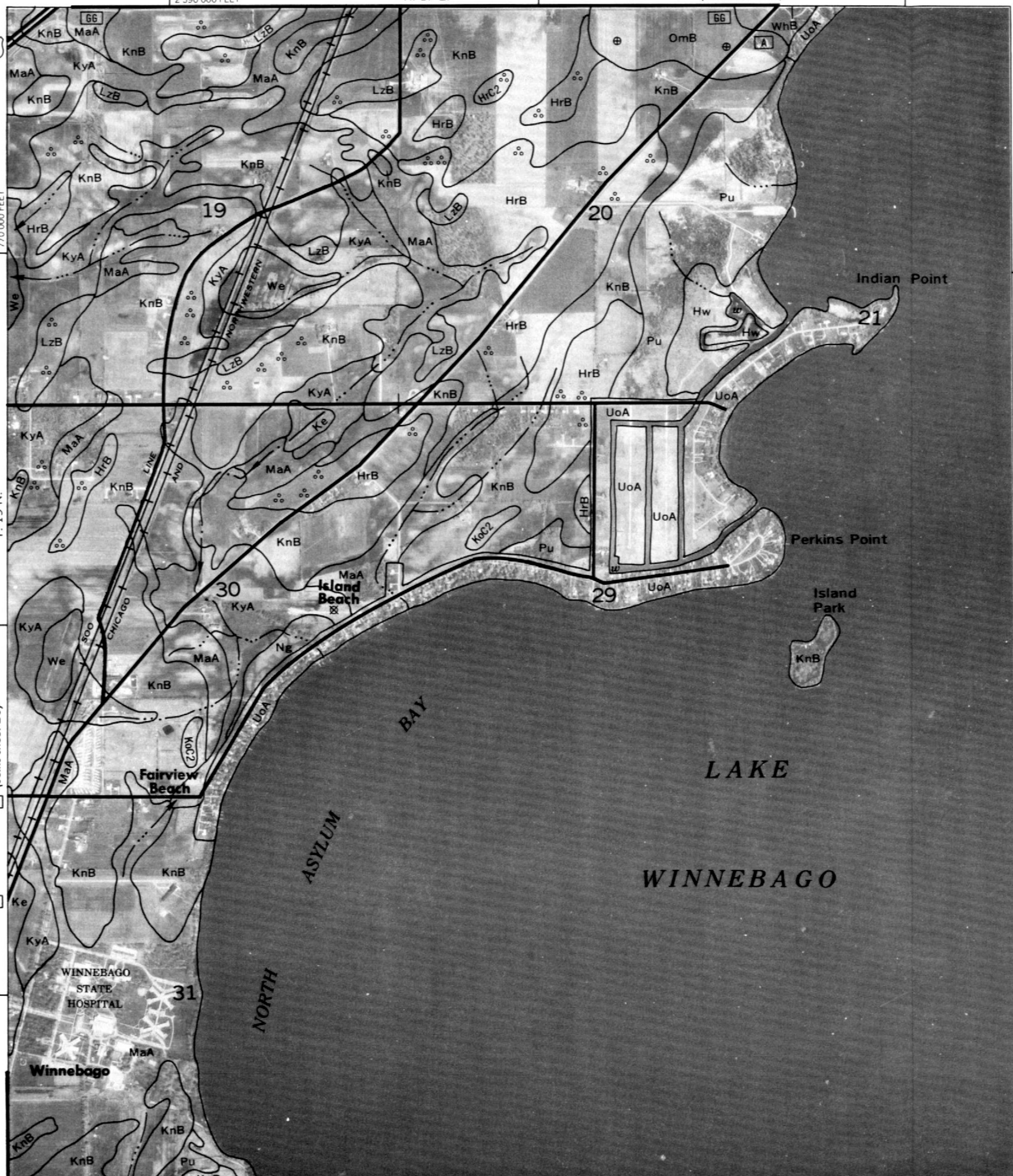
2 390 000 FEET

(Joins sheet 16)

770 000 FEET

T. 19 N.

(Joins sheet 20)



760 000 FEET

(Joins upper right)

2 400 000 FEET

R. 17 E.

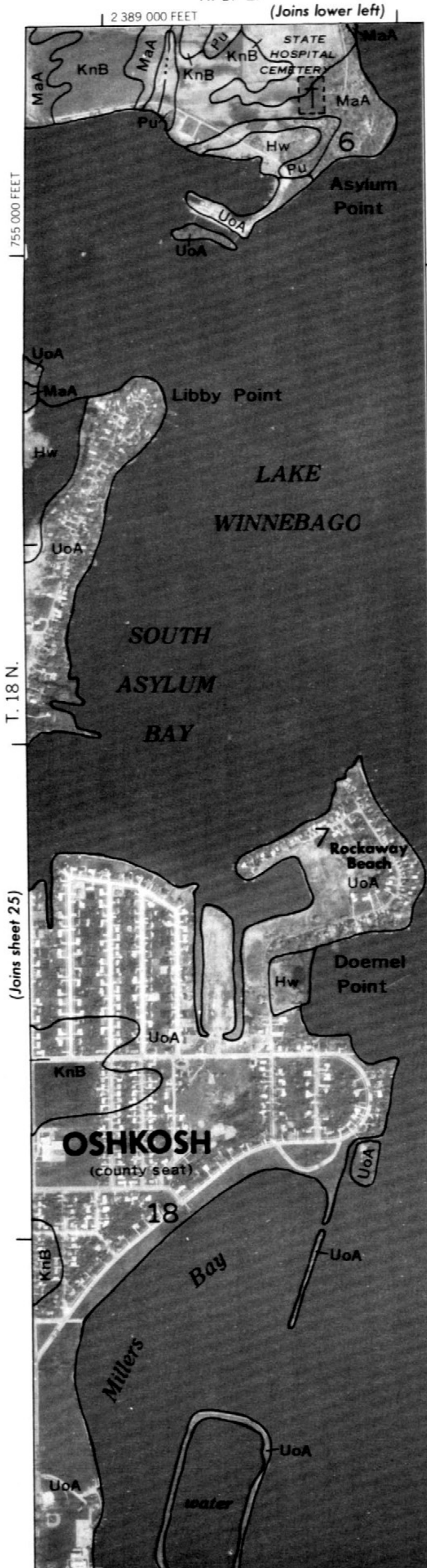
2 389 000 FEET

(Joins lower left)

755 000 FEET

T. 18 N.

(Joins sheet 25)

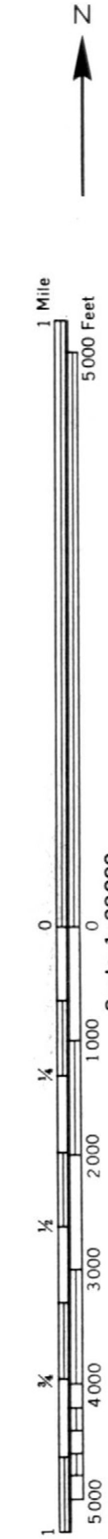


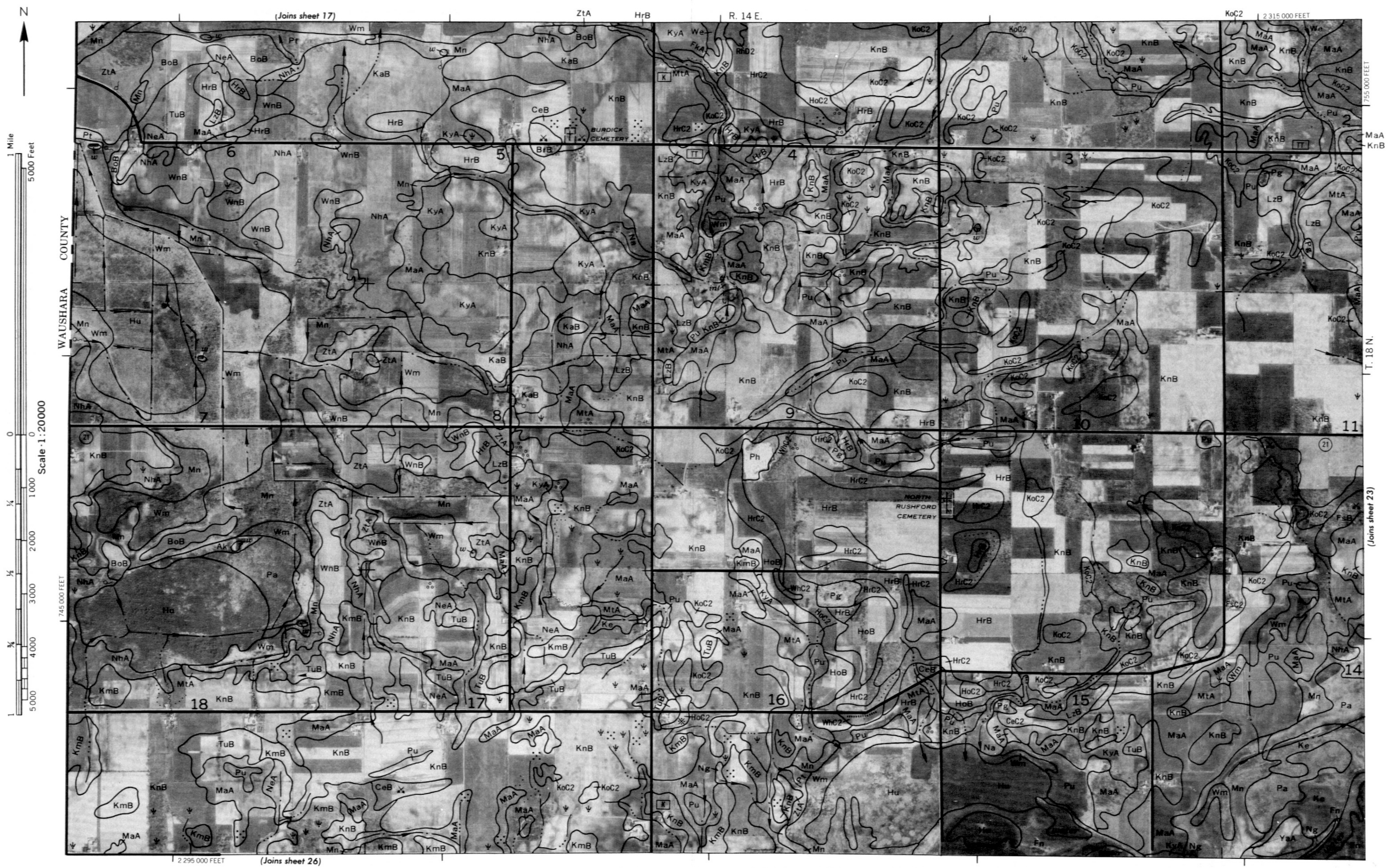
745 000 FEET

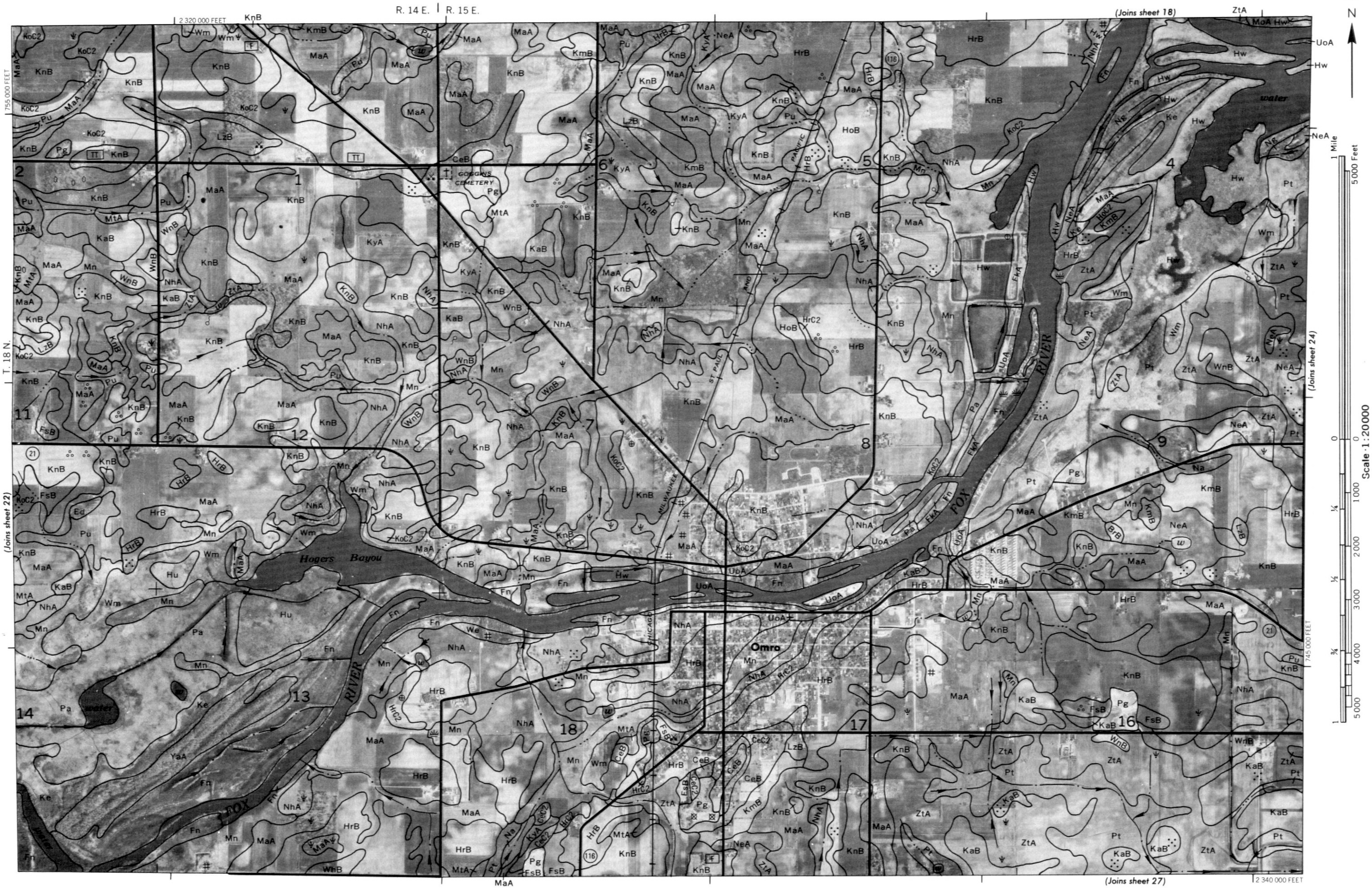
(Joins inset, sheet 34)

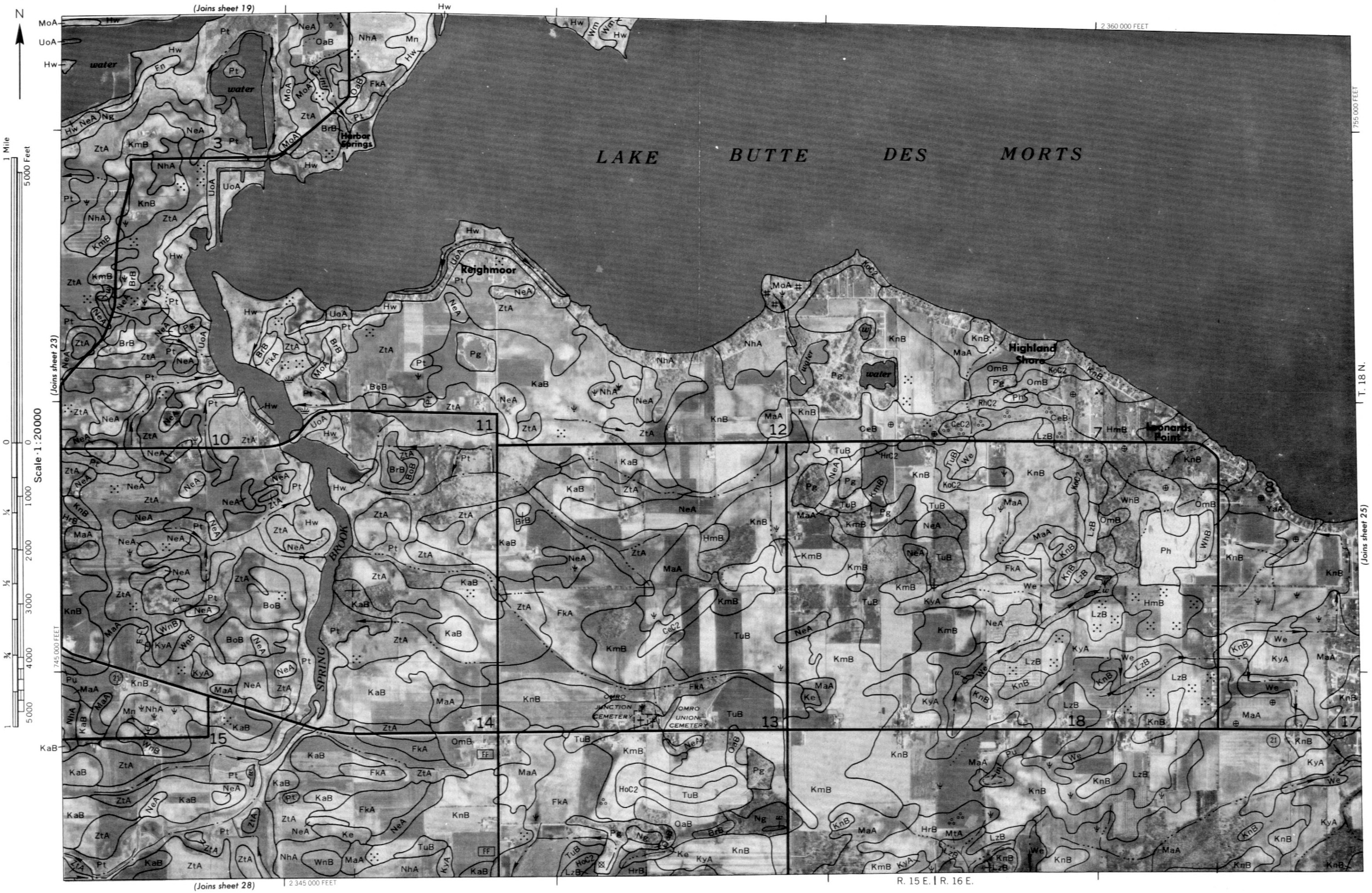
2 392 000 FEET

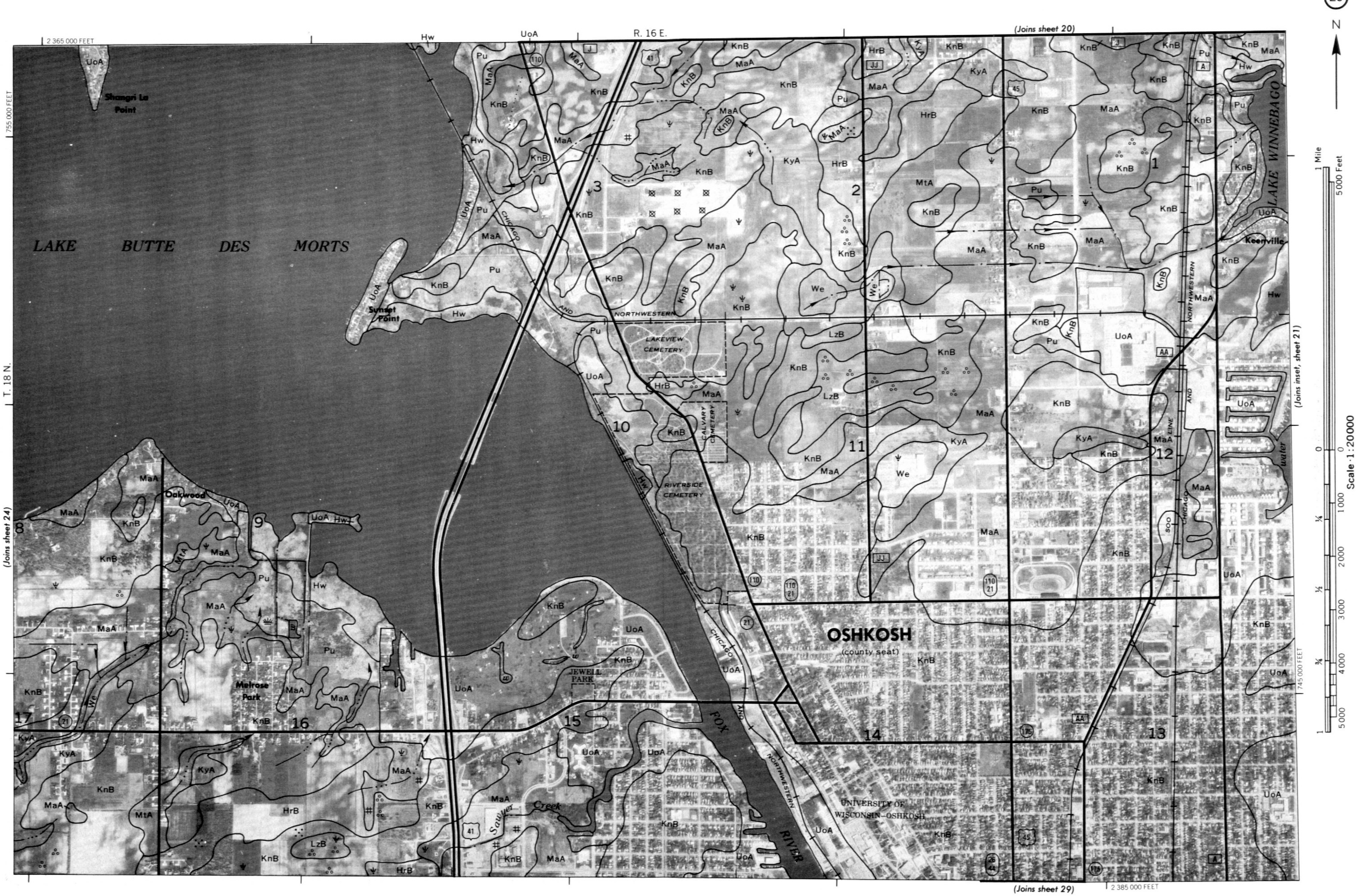
3000 AND 5000-FOOT GRID TICKS

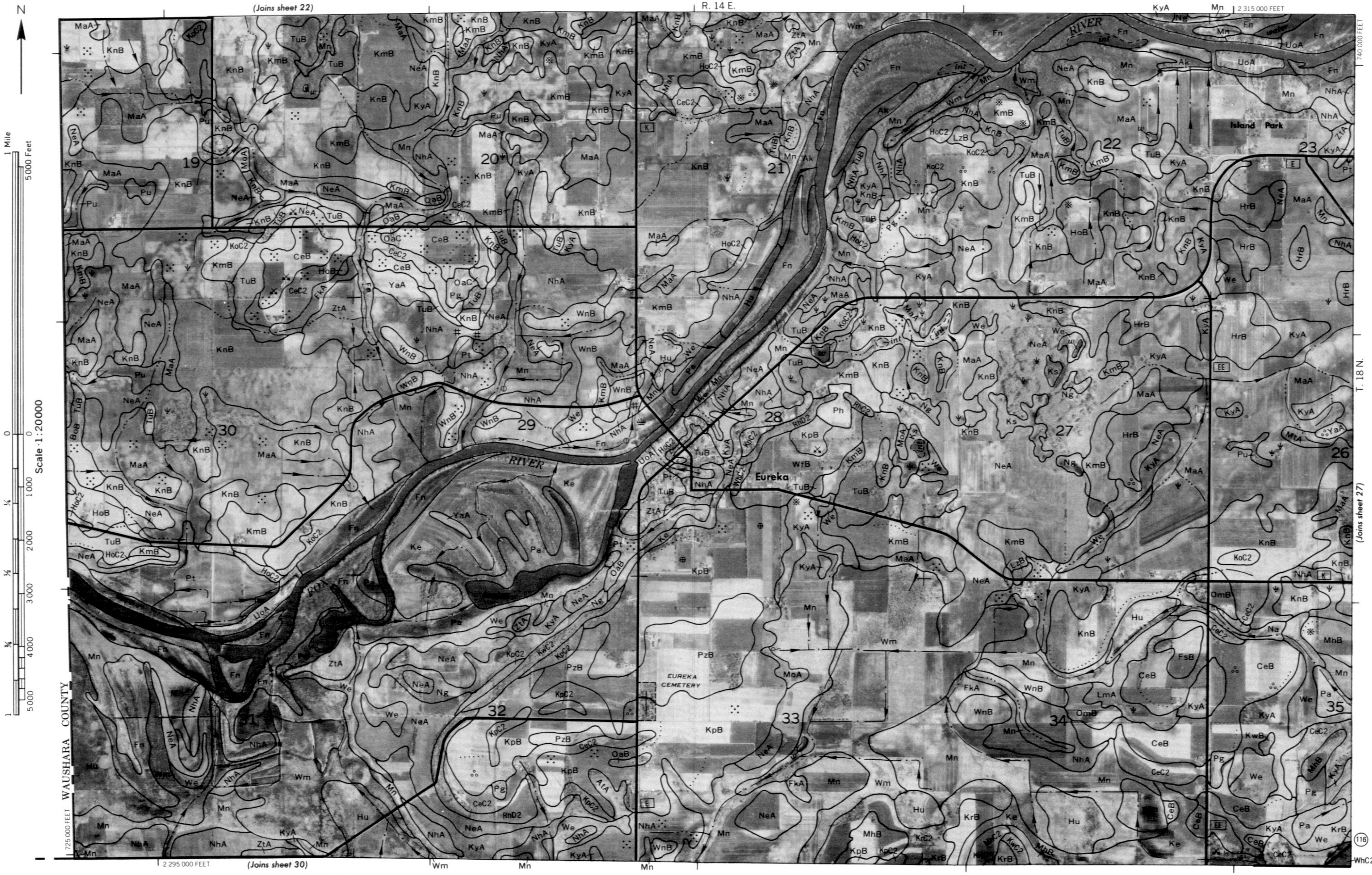



N
(Joins sheet 17)
R. 14 E.
2 315 000 FEET
755 000 FEET
BURDICK CEMETERY
NORTH RUSHFORD CEMETERY
WAUSHARA COUNTY
T. 18 N.
(Joins sheet 23)
745 000 FEET
2 295 000 FEET
(Joins sheet 26)
1 Mile
5000 Feet
Scale 1:20000

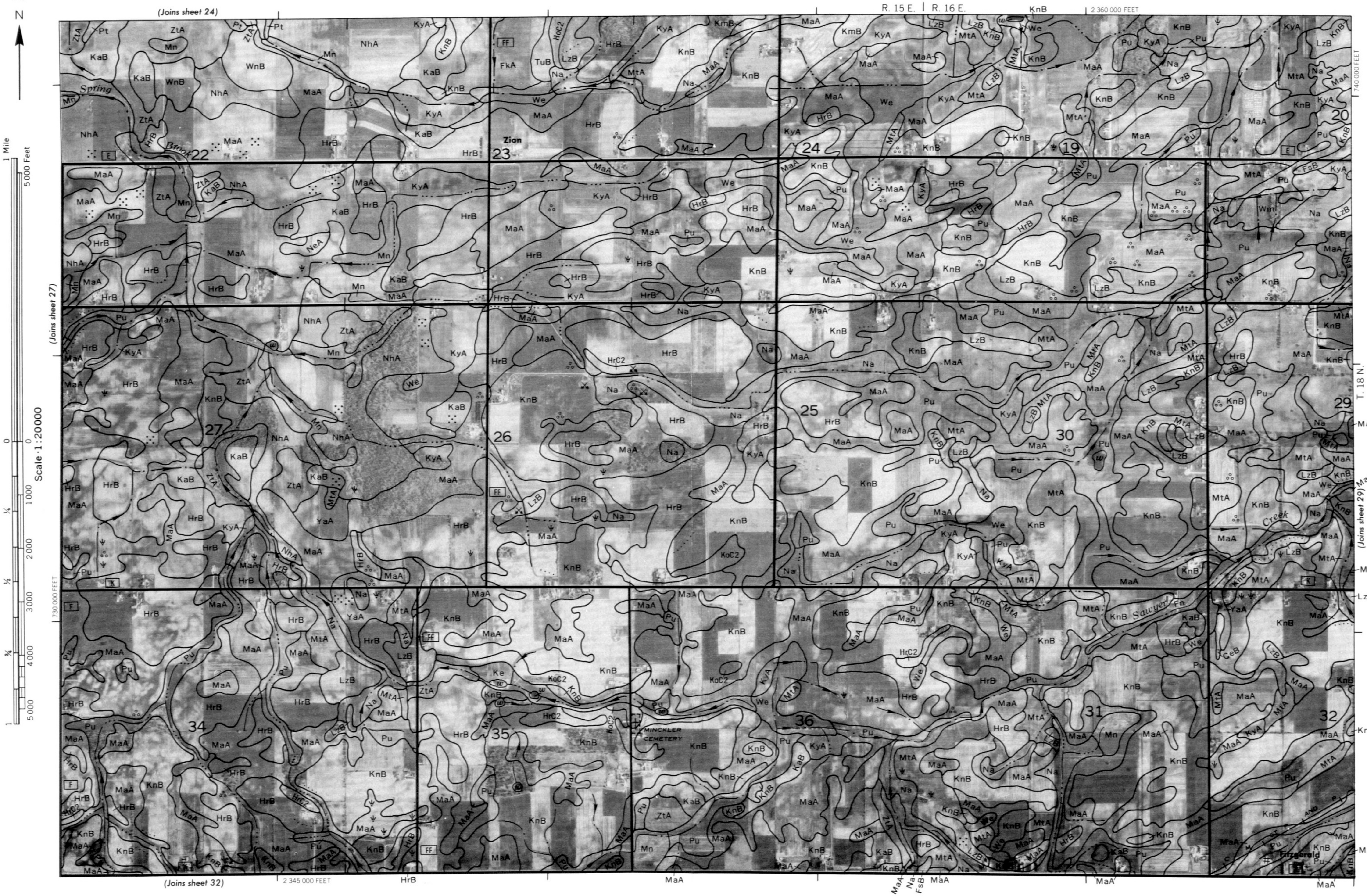

R. 14 E.
R. 15 E.
T. 18 N.
2 320 000 FEET
755 000 FEET
745 000 FEET
2 340 000 FEET
(Joins sheet 18)
(Joins sheet 22)
(Joins sheet 24)
(Joins sheet 27)
N
1 Mile
5000 Feet
Scale 1:20000
GOGGINS CEMETERY
Hogers Bayou
FOX RIVER
Omro
water
CHICAGO MILWAUKEE ST PAUL AND PACIFIC

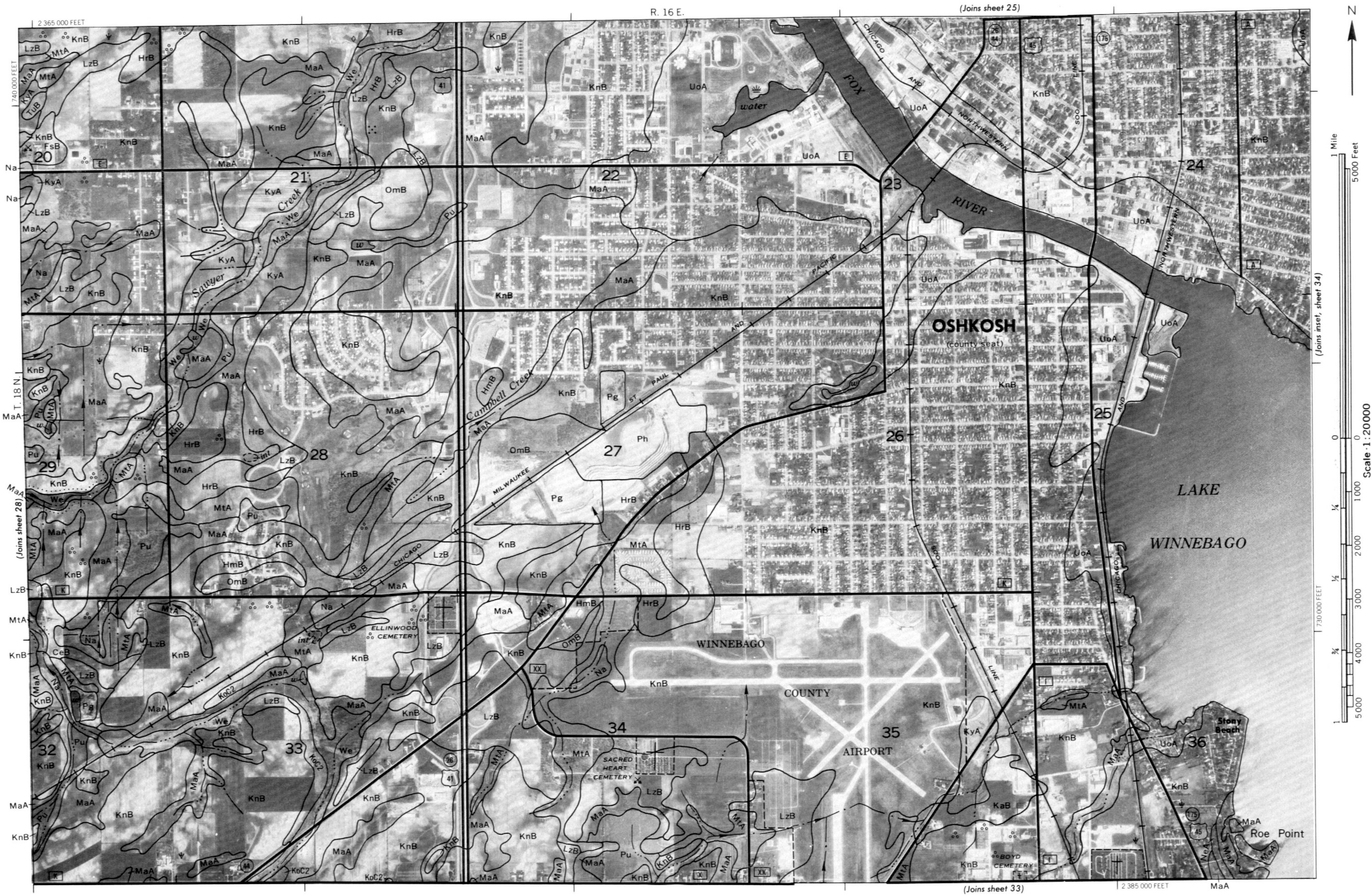

N
(Joins sheet 19)
(Joins sheet 23)
(Joins sheet 25)
(Joins sheet 28)
LAKE BUTTE DES MORTS
water
Harbor Springs
Reighmoor
Highland Shore
Leonards Point
SPRING BROOK
OMRO JUNCTION CEMETERY
OMRO UNION CEMETERY
2 360 000 FEET
2 345 000 FEET
755 000 FEET
745 000 FEET
T. 18 N.
R. 15 E. | R. 16 E.
1 Mile
5000 Feet
Scale 1:20000

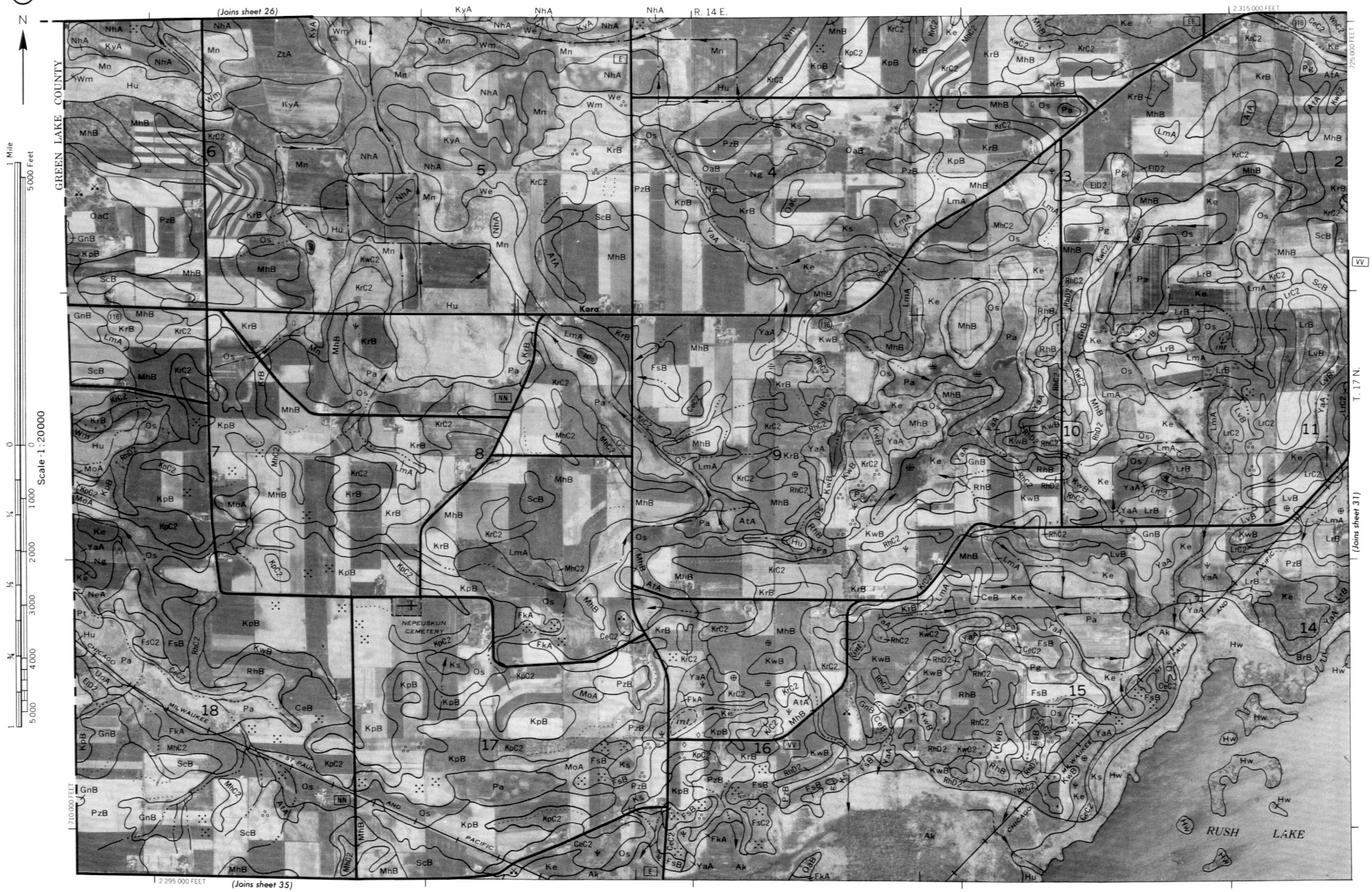

25
N
(Joins sheet 20)
(Joins sheet 29)
(Joins sheet 24)
(Joins inset, sheet 21)
R. 16 E.
T. 18 N.
2 365 000 FEET
2 385 000 FEET
755 000 FEET
745 000 FEET
LAKE BUTTE DES MORTS
LAKE WINNEBAGO
Shangri La Point
Sunset Point
Keenville
Oakwood
Melrose Park
OSHKOSH
(county seat)
LAKEVIEW CEMETERY
CALVARY CEMETERY
RIVERSIDE CEMETERY
JEWELL PARK
UNIVERSITY OF WISCONSIN - OSHKOSH
FOX RIVER
Sawyer Creek
CHICAGO AND NORTHWESTERN
SOO LINE
Scale 1:20000
1 Mile
5000 Feet

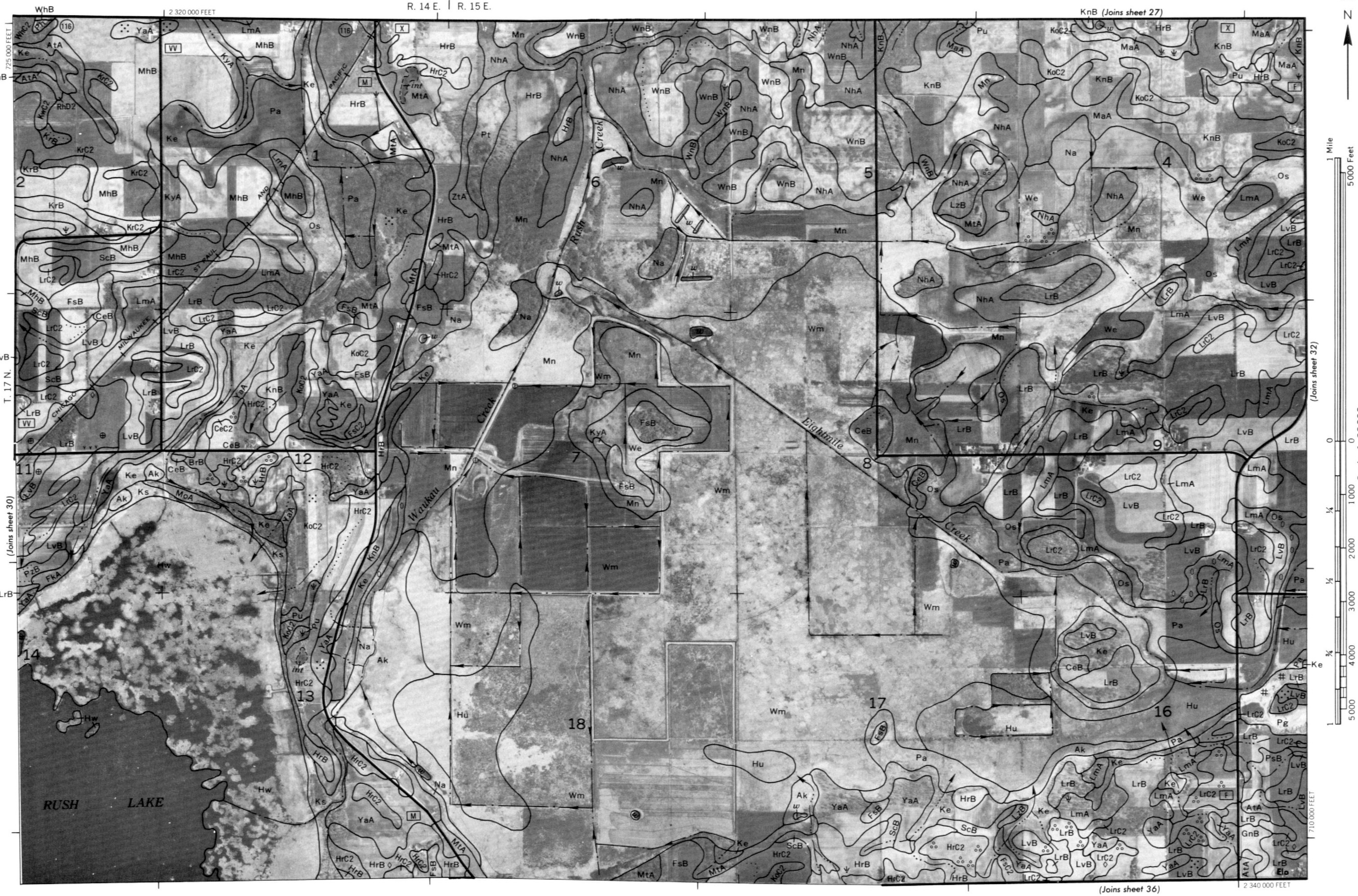

N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
(Joins sheet 22)
(Joins sheet 27)
(Joins sheet 30)
R. 14 E.
T. 18 N.
2 315 000 FEET
740 000 FEET
725 000 FEET
2 295 000 FEET
FOX RIVER
Island Park
Eureka
EUREKA CEMETERY
WAUSHARA COUNTY
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
116

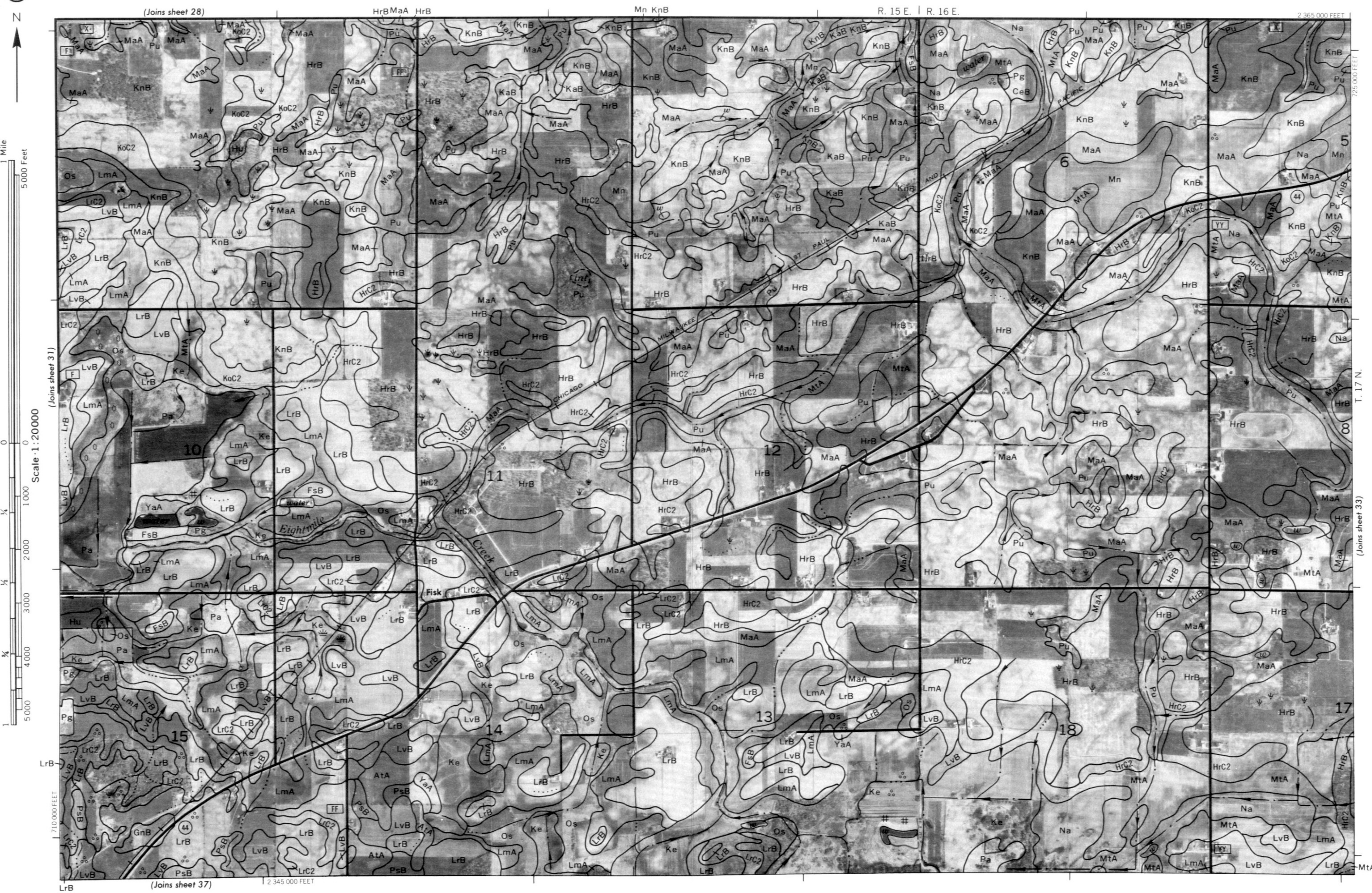

27
N
R. 14 E.
R. 15 E.
2 320 000 FEET
740 000 FEET
(Joins sheet 23)
(Joins sheet 28)
(Joins sheet 26)
(Joins sheet 31)
730 000 FEET
2 340 000 FEET
T. 18 N.
OMRO CEMETERY
TICE CEMETERY
Waukau
Rush Creek
Spring Brook
water
MILWAUKEE
CHICAGO
ST PAUL
PACIFIC
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36
1 Mile
5000 Feet
Scale 1:20000

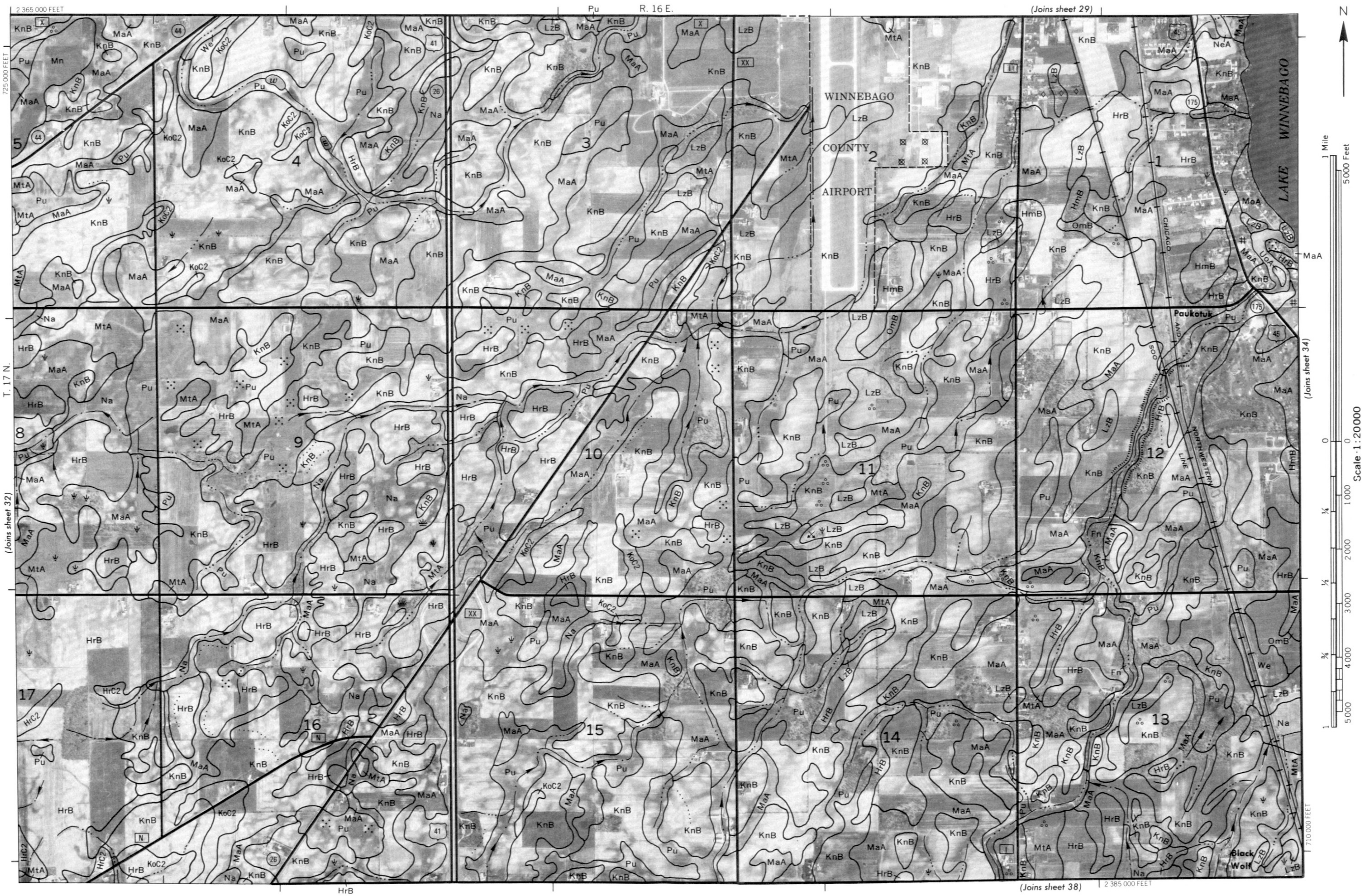

N
(Joins sheet 24)
(Joins sheet 27)
(Joins sheet 29)
(Joins sheet 32)
R. 15 E.
R. 16 E.
T. 18 N.
2 360 000 FEET
740 000 FEET
730 000 FEET
2 345 000 FEET
Scale 1:20000
1 Mile
5000 Feet
Spring
Brook
Zion
Creek
Sawyer
MINCKLER CEMETERY
Fitzgerald
19
20
22
23
24
25
26
27
29
30
31
32
34
35
36


N
(Joins sheet 25)
R. 16 E.
2 365 000 FEET
740 000 FEET
T. 18 N.
(Joins sheet 28)
(Joins inset, sheet 34)
(Joins sheet 33)
2 385 000 FEET
730 000 FEET
OSHKOSH
(county seat)
LAKE
WINNEBAGO
FOX
RIVER
water
Sawyer
Creek
Campbell Creek
CHICAGO
MILWAUKEE
ST. PAUL
AND
PACIFIC
CHICAGO
AND
NORTHWESTERN
SOO
LINE
WINNEBAGO
COUNTY
AIRPORT
ELLINWOOD
CEMETERY
SACRED
HEART
CEMETERY
BOYD
CEMETERY
Stony
Beach
Roe Point
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
1 Mile
5000 Feet
Scale 1:20000

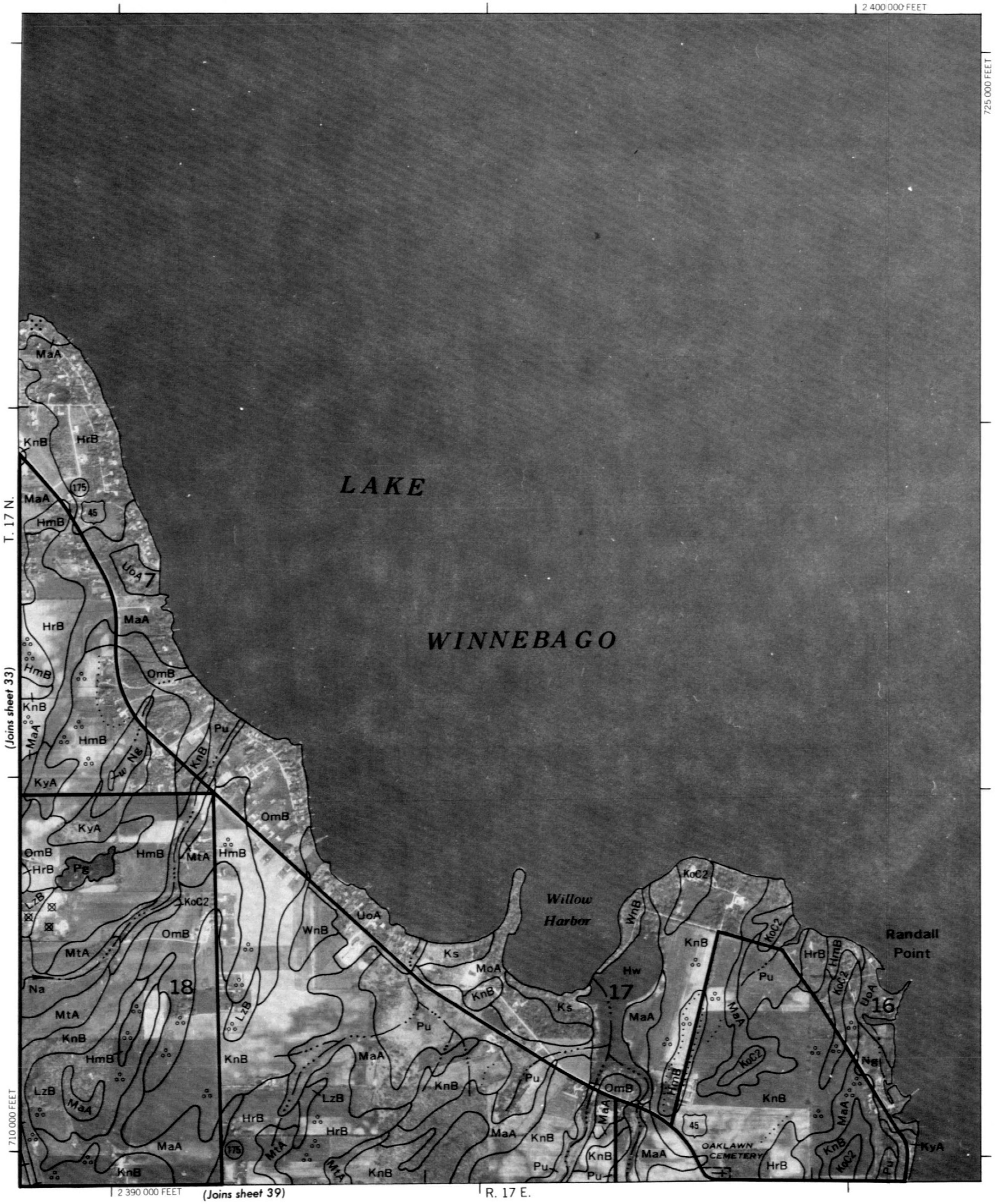

(Joins sheet 26)
R. 14 E.
2 315 000 FEET
725 000 FEET
N
GREEN LAKE COUNTY
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
T. 17 N.
(Joins sheet 31)
Kora
NEPEUSKUN CEMETERY
CHICAGO MILWAUKEE ST PAUL AND PACIFIC
RUSH LAKE
210 000 FEET
2 295 000 FEET
(Joins sheet 35)
1
2
3
4
5
6
7
8
9
10
11
14
15
16
17
18

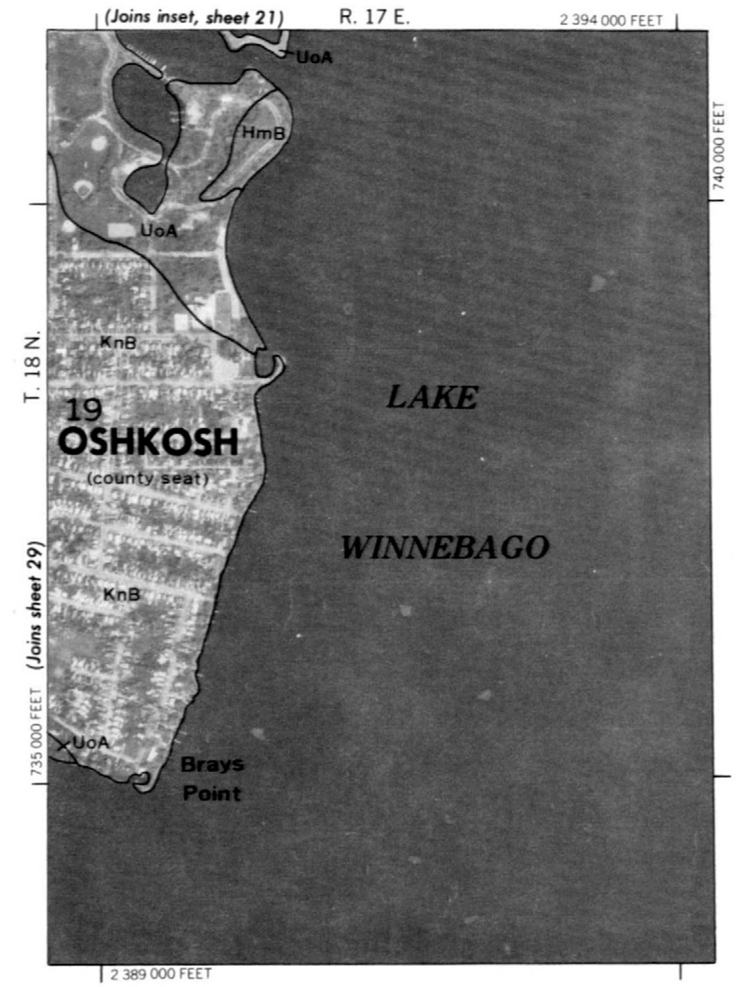

R. 14 E. | R. 15 E.
2 320 000 FEET
725 000 FEET
KnB (Joins sheet 27)
N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
(Joins sheet 32)
(Joins sheet 30)
(Joins sheet 36)
T. 17 N.
710 000 FEET
2 340 000 FEET
RUSH LAKE
Rush Creek
Waukau Creek
Eightmile Creek
CHICAGO MILWAUKEE ST PAUL AND PACIFIC
1
2
4
5
6
7
8
9
11
12
13
14
16
17
18


N
(Joins sheet 28)
R. 15 E.
R. 16 E.
2 365 000 FEET
725 000 FEET
(Joins sheet 31)
(Joins sheet 33)
T. 17 N.
(Joins sheet 37)
2 345 000 FEET
710 000 FEET
1 Mile
5 000 Feet
Scale 1:20000
Fisk
Eightmile
Creek
CHICAGO
MILWAUKEE
ST PAUL
AND
PACIFIC


33
N
2 365 000 FEET
725 000 FEET
R. 16 E.
(Joins sheet 29)
T. 17 N.
(Joins sheet 32)
(Joins sheet 34)
(Joins sheet 38)
2 385 000 FEET
710 000 FEET
WINNEBAGO
COUNTY
AIRPORT
LAKE WINNEBAGO
Paukotuk
Black Wolf
CHICAGO AND NORTHWESTERN LINE
SOO LINE
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
0
¼
½
¾
1

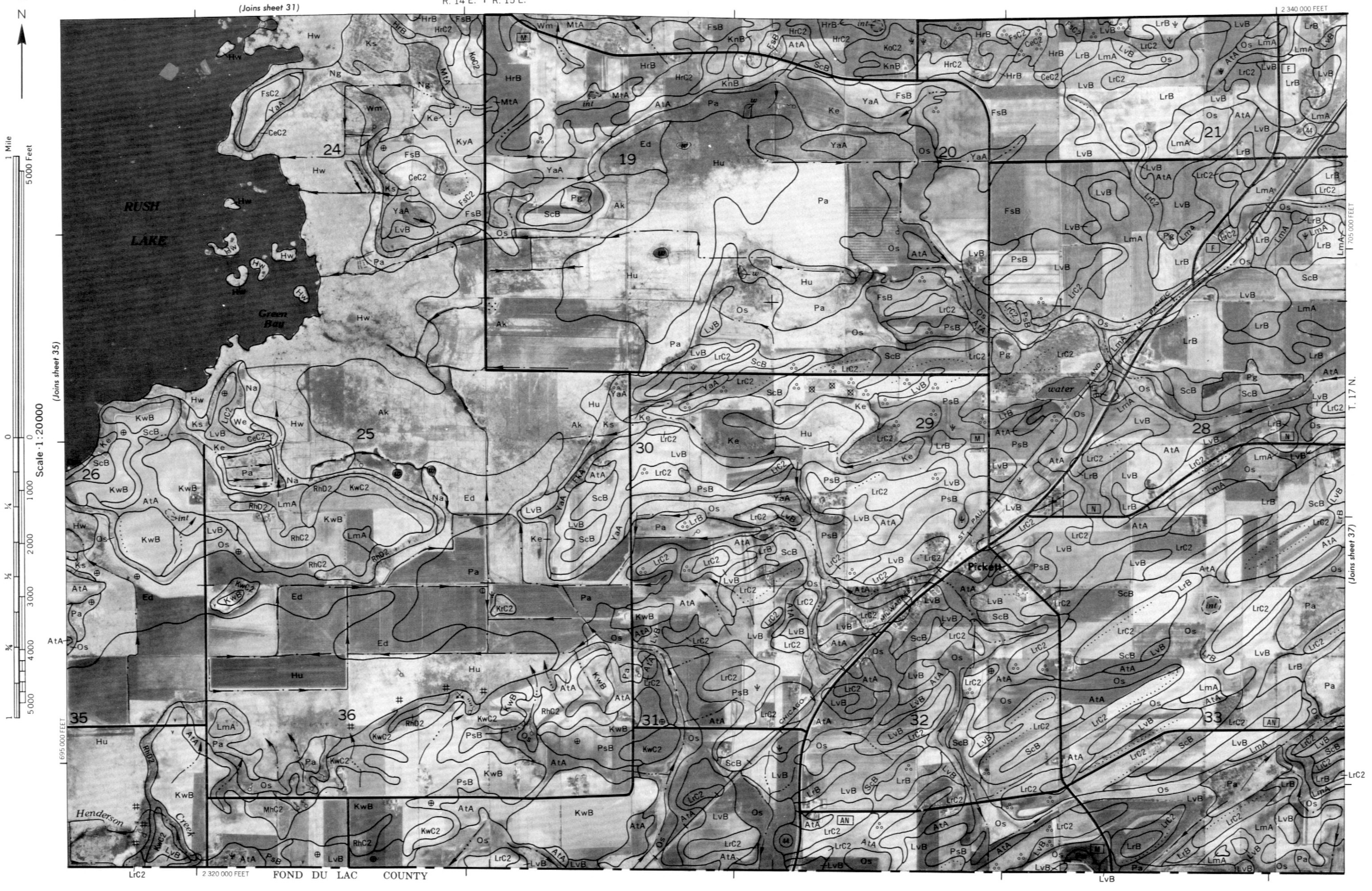

N
1 Mile
5000 Feet
Scale 1:20 000
0
1000
2000
3000
4000
5000
¼
½
¾
1

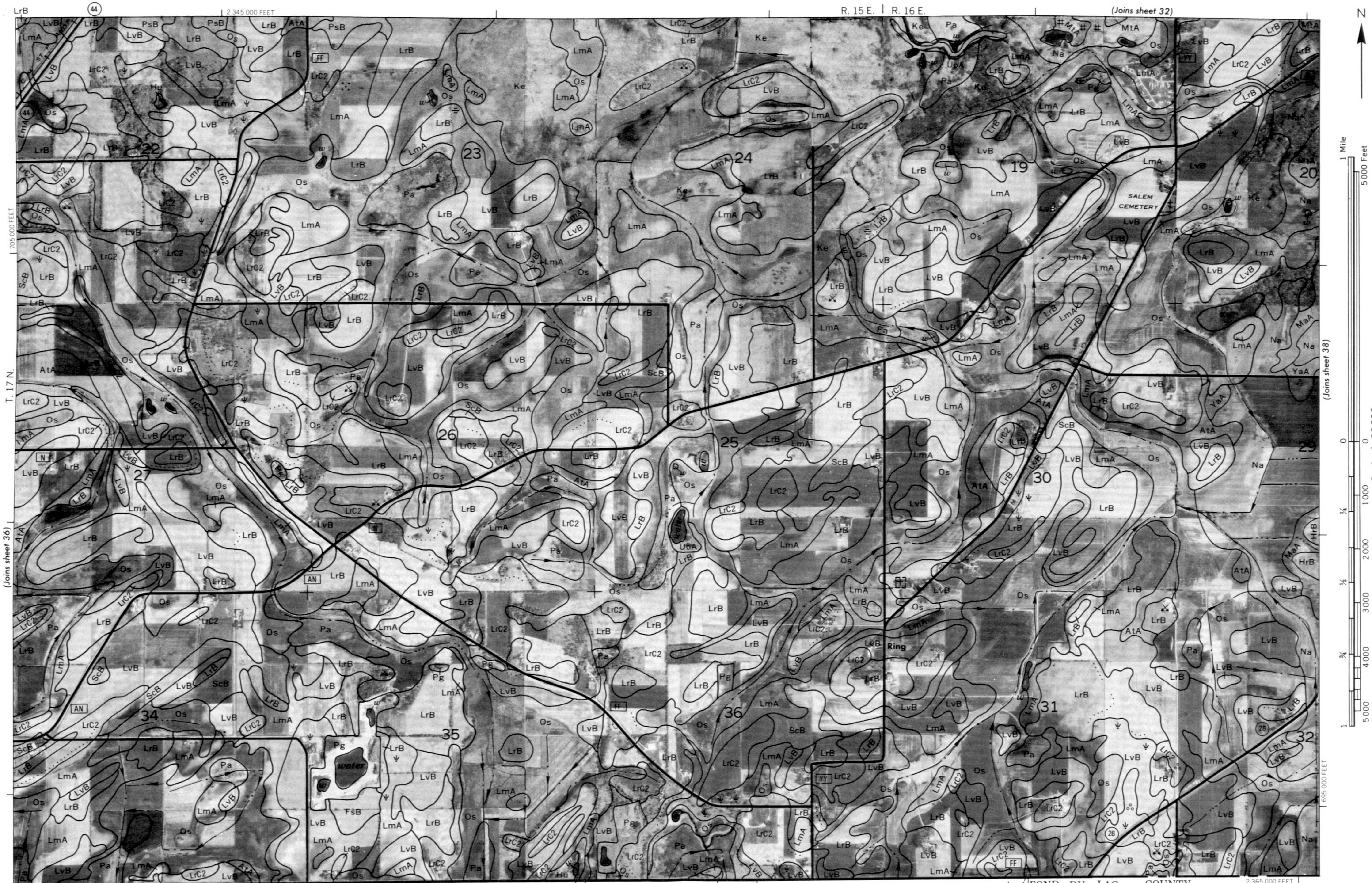

2 400 000 FEET
725 000 FEET
710 000 FEET
2 390 000 FEET
(Joins sheet 39)
R. 17 E.
T. 17 N.
(Joins sheet 33)
LAKE
WINNEBAGO
Willow
Harbor
Randall
Point
OAKLAWN
CEMETERY
7
18
17
16
175
45
MaA
KnB
HrB
HmB
UoA
OmB
Pu
KyA
Pg
LzB
KoC2
MtA
WnB
Na
Ks
MoA
Hw
Ne
KyA

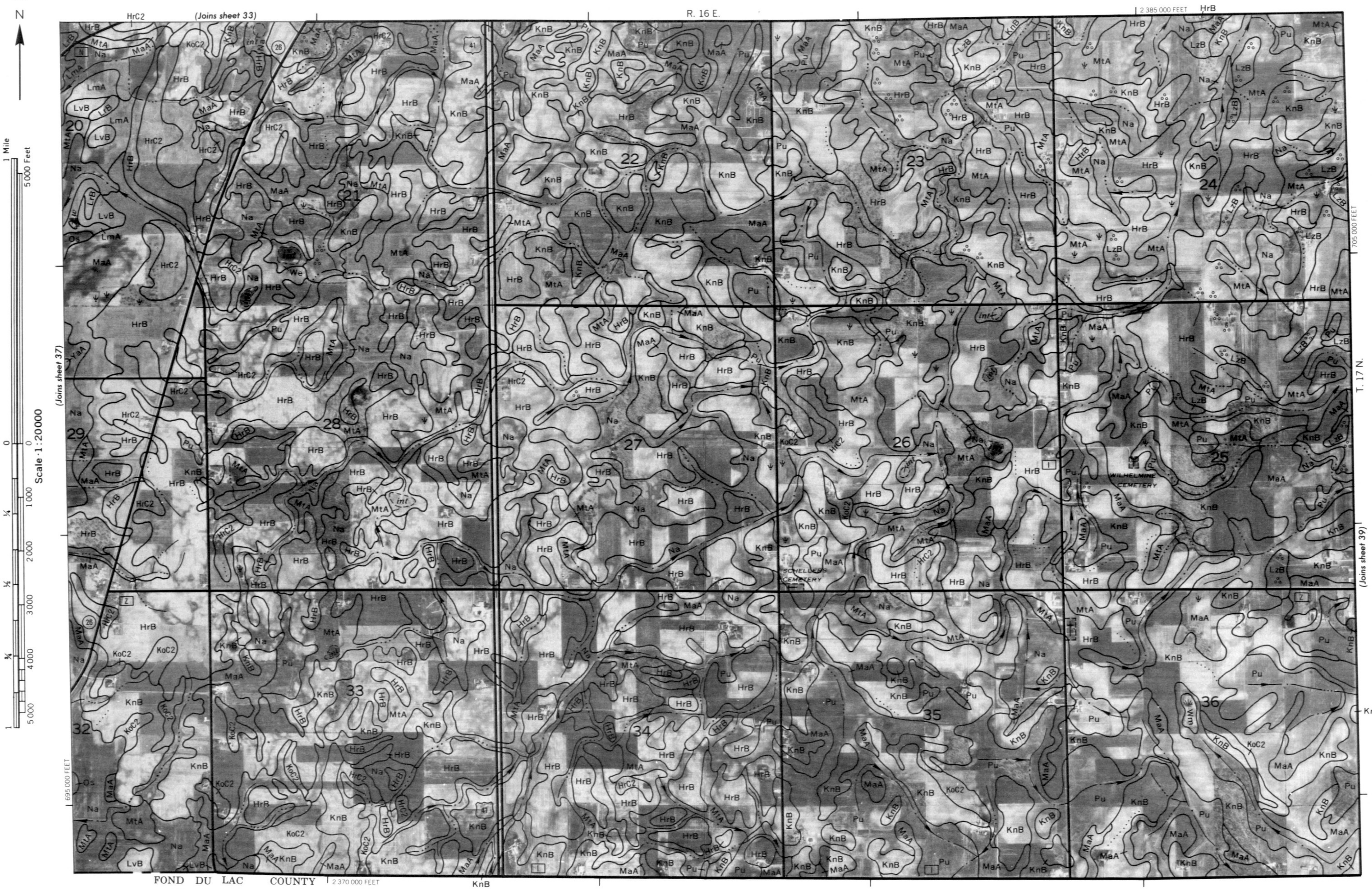

(Joins inset, sheet 21)
R. 17 E.
2 394 000 FEET
740 000 FEET
735 000 FEET
2 389 000 FEET
T. 18 N.
(Joins sheet 29)
19
OSHKOSH
(county seat)
LAKE
WINNEBAGO
Brays
Point
UoA
HmB
KnB

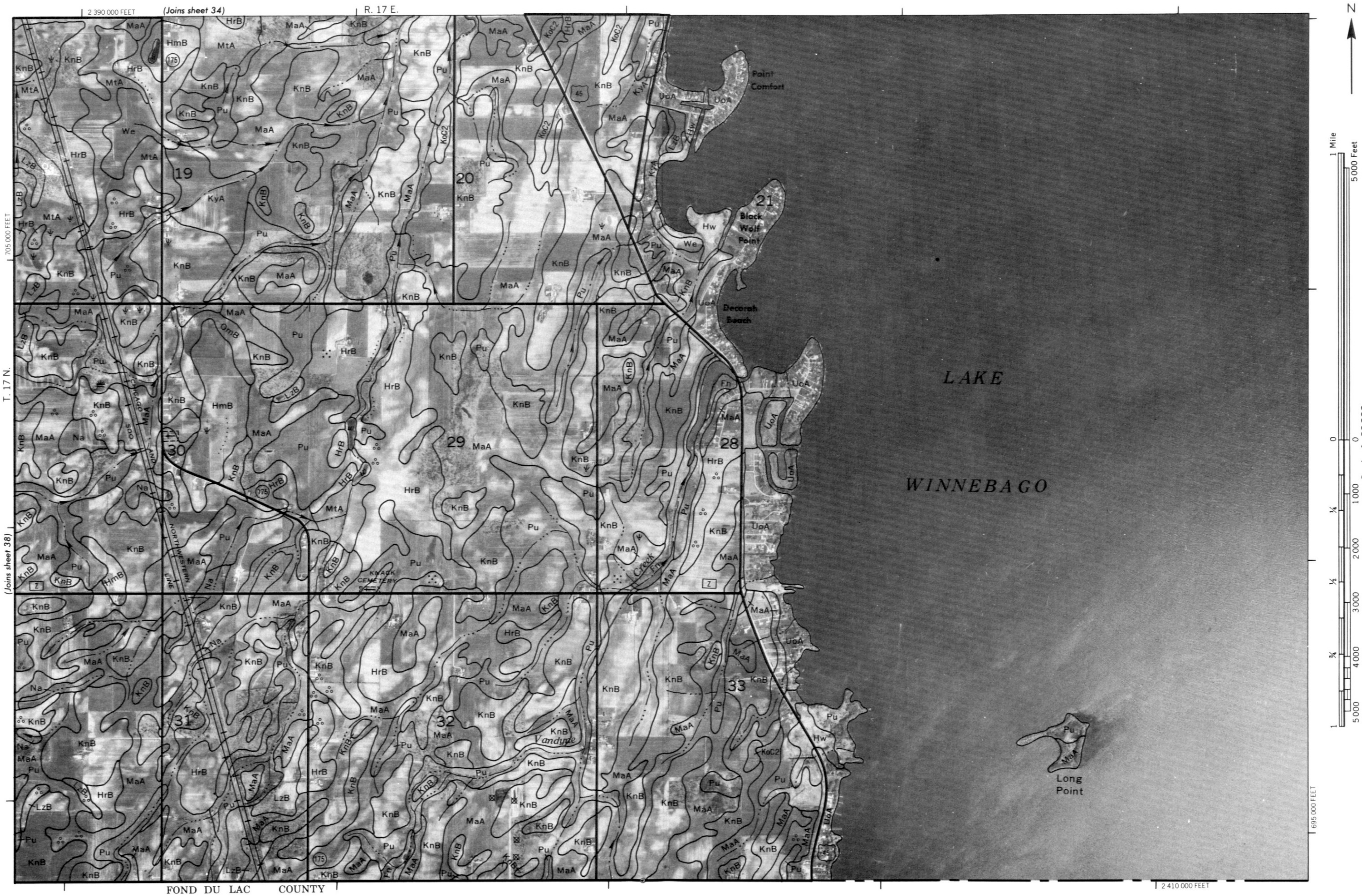

35
N
2 295 000 FEET
R. 14 E.
(Joins sheet 30)
705 000 FEET
T. 17 N.
GREEN LAKE COUNTY
FOND DU LAC COUNTY
Rush Lake
RUSH LAKE
(Joins sheet 36)
Gleason Bay
Henderson Creek
695 000 FEET
2 315 000 FEET
19
20
21
22
26
27
28
29
30
31
32
33
34
35
1 Mile
5000 Feet
Scale 1:20000

WINNEBAGO COUNTY, WISCONSIN — SHEET NUMBER 36




2 345 000 FEET
R. 15 E.
R. 16 E.
(Joins sheet 32)
N
T. 17 N.
705 000 FEET
(Joins sheet 36)
(Joins sheet 38)
SALEM CEMETERY
Ring
FOND DU LAC COUNTY
2 365 000 FEET
695 000 FEET
1 Mile
5000 Feet
Scale 1:20000


N
(Joins sheet 33)
R. 16 E.
2 385 000 FEET
705 000 FEET
T. 17 N.
(Joins sheet 37)
(Joins sheet 39)
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
695 000 FEET
2 370 000 FEET
FOND DU LAC COUNTY
WILHELMINE CEMETERY
SCHELLERS CEMETERY
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36


2 390 000 FEET
(Joins sheet 34)
R. 17 E.
N
T. 17 N.
705 000 FEET
(Joins sheet 38)
Point Comfort
Black Wolf Point
Decorah Beach
LAKE WINNEBAGO
Long Point
KNAACK CEMETERY
Creek
Vandyne
CHICAGO AND NORTHWESTERN LINE
SOO LINE
19
20
21
28
29
30
31
32
33
695 000 FEET
2 410 000 FEET
FOND DU LAC COUNTY
1 Mile
5000 Feet
Scale 1:20000